THE

ELECTRICAL REVIEW.

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NOTICE OF REMOVAL.

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ELECTRIC RAILWAYS.

So far as concerns the development in this country, during the next few years, of electric tramway traction, it is, we are glad to think, becoming a somewhat familiar task for the technical press to give vent to blame for past delays, coupled with hopes for more rapid progress in the early future, and we do not propose just now to inflict any more of these jeremiads or aspirations upon our readers in this particular direction. There is no great need for it, as the country seems really at last to be awake, especially so in its municipal departments, and the next 10 years will probably show more than twenty-fold the number of electric lines at present owned and operated by local authorities.

There is, however, still a great deal of uphill missionary work and steady pioneering before those who have confidence in electric traction for railway work, may hope to see the same extent of progress as ought reasonably to come at once in regard to our tramways.

The reason is obvious, and hardly needs mention. To equip a railway for electric working involves a much greater disturbance of existing methods and appliances than in the case of tramways; moreover, our steam roads have been longer established, the cost of conversion would be very heavy, in direct proportion almost to the magnitude of the line (and, therefore, to the benefits that might accrue from the use of electric traction, though it is hard to convince railway managers and directors that such a statement is reliably true).

Of course, there is no trouble in deciding upon electric traction for underground deep level lines. Steam is obviously impossible, for want of efficient ventilation; the present shallow tunnel lines in London are unbearable enough. The only alternatives are cable or compressed air. The latter is out of the question for economic reasons; the former (although employed at Glasgow) is regarded by many with distrust, that has at least some ground for its existence.

Similarly elevated lines, to the limited extent that they may arise in this country, will also without doubt be operated electrically; but it is when we come to surface lines that the hard work of introducing new methods is most encountered.

The main trouble of it is that the chief advantages lying on the side of electric traction are either such as cannot very easily be invested with absolute money value, or else can only be ascertained by actual experiment in each case, under which conditions the railway companies are almost in the position of the man who said that he had no doubt the water was most enjoyable on a summer's day, but he wasn't going to bathe until he could swim.

There is no very great saving in the matter of fuel, as has been pointed out again and again; for although the stationary Corliss engine at a power house may run for less than 2 lbs. of coal per I.H.P., whilst the ordinary passenger locomotive burns anything up to 40 lbs. per mile (which works out to perhaps 5, 6, 7, or 8 lbs. per I.H.P.) yet the

intervening transformations on the electric line bring the two fuel expenditures a good deal nearer to one another, if they do not become almost identical.

Moreover, the cost of fuel is *not* the chief item in running a railway, although it is an important one. Labour accounts for two or three times as much as the coal bill, and any advantages of electric traction that tend to reduce the train or station staffs, either in mere numbers or in expensiveness, are far more to be emphasised than a so-called fuel economy, which does not amount to much in the end.

That there are such advantages now in existence, and that others will speedily be found out as electric railways become more common, may be regarded as solid fact; for instance, given a sufficiently reliable track, the use of electric trains upon a railway can at once effect a large saving of time in transit by increasing the average speed with safety up to 80, or even 100 miles an hour. What is the value of such abbreviated journeys to passengers and to the railway? The abolition of heavy reciprocating parts, such as are found necessary in a steam engine, which oscillate, perhaps, four or five times *per second*, would, and does, give a much easier and more pleasant running. This has a value both to passengers and those responsible for maintaining the track and rolling stock. No heavy tender or boiler is required, and the saving of dead non-paying load thus effected may easily amount to one-quarter of the total train load for high speeds.

Economies are also to be looked for in the direction of automatic signalling worked by electricity; and the importance of this may be estimated when one considers the number of signal boxes, of the men employed, and the wages annually paid for work that the trains themselves can be made to do with equal, if not even greater, security. It is, indeed, maintained by many (and events sometimes seem to prove it) that the life and death of the passenger ought not to be left to the care of men as admittedly smart and careful as are the average railway signalmen. Considering the responsible work they do, they are by no means too well paid. Even with their continued employment, the use of electric traction increases enormously the ease of block working, due to the ready way in which the trains may be handled and combined, if necessary, so as to save the labour of signalling a dozen trains, where three would suffice, when run together on through service.

This power of combining cars to form a train, or of short trains to form a long one, is by no means one of the least important advantages afforded by electric traction.

No more rolling stock need be used to make up a train than is really required, since cars may be attached or taken off at almost a moment's notice, and as they are all presumably self-operative, each additional car provides its own share of the motive power.

The most suitable methods by which this very desirable state of affairs can be attained are not difficult to imagine; and on another page in this issue we deal with a descriptive account of a system of regulation by means of which the train staff may reach a minimum.

The introduction of such devices marks a great step forward in electric railway work, and much credit is due to Mr. Sprague for leading the way. Without implying that further great advances have yet to be made in order to achieve a practical success, we may yet say with truth that other improvements will no doubt follow, each one worthy of adoption; but that if opportunity be now offered for the equipment of electric railways, we should feel ample confidence in prophesying the best results, both from an engineering and a financial standpoint, of course with due credit given to those qualities already spoken of as not easily rendered into £ s. d.

Notes on the Theory of Lead Accumulators.

The part which persulphuric acid is allowed to play in the life history of the secondary cell has recently been the subject of very much discussion, especially amongst German experts, and the matter is by no means settled, since papers are continually appearing giving accounts of investigations that have been carried out. Amongst these we may notice one by Karl Elbs and O. Schönherr in the *Chemiker Centralblad*, 1895, p. 591. These have determined the relationship between the amount of persulphuric acid formed and the concentration of the sulphuric acid which is electrolysed. Details are given respecting the method of estimating the acid. If the density of the sulphuric acid is below 1·2, very little persulphuric acid is formed; the maximum amount is obtained when the acid has a specific gravity equal to 1·35—1·5. The authors are of opinion that the persulphuric acid is formed by the combination of HSO_4 ions at the anodes, and is not due to oxidation, since the amount formed is greater with a stronger current, whereas if it were a simple oxidation product the amount formed would decrease with an increase in the strength of the current. Too great a concentration of the acid retards the formation of persulphuric acid for several reasons:—(1) Concentrated acid is a bad conductor; (2) the molecules of $H_2S_2O_8$ when formed in a concentrated acid are not so free to move as in the more mobile dilute acid, and hence remain a longer time at the anode and hence become decomposed; (3) with concentrated acid, the amount of heat developed is greater, and, hence, destroys a greater number of persulphuric acid molecules. When a strong current is passed through a moderately dilute acid, it is broken. On warming, however, the electrolysis begins anew. This stoppage is caused by the accumulation of too many ions, and the formation of a coating of the non-conducting HSO molecules round the anode. The amount of persulphuric acid formed is also diminished by increase of temperature; at 60° it is decomposed as rapidly as formed. With dilute acid (sp. gr. 1·3), practically no hydrogen peroxide is formed by the decomposition of the persulphuric acid, the amount of peroxide, however, increases with the strength of the acid. When diluted with 50 times its volume of cold water, persulphuric acid is not decomposed. In the same paper there is an account of another research by Karl Elbs on the same subject (*vide* p. 476). He demonstrates the formation of persulphuric acid and of its potassium salt in a wide test tube filled with the electrolyte, the anode being a platinum wire enclosed for the greater part of its length in a glass tube, and the cathode a platinum ring. A wider tube, surrounding the anode, collects the bubbles of gas evolved and prevents their reaching the cathode. The whole apparatus is placed in a beaker of cold water. A current of 100 amperes per square metre anode surface is used. With sulphuric acid of sp. gr. 1·4, persulphuric acid can be detected in the liquid round the anode after five minutes. With a cold saturated solution of potassium sulphate in dilute sulphuric acid a considerable amount of crystallised potassium persulphate is obtained at the end of ten minutes. The ammonium salt requires a longer time. The same apparatus may be used for showing the conversion of cobaltous into cobaltic salts. In conclusion Elbs discusses the hypothesis of lead accumulators put forward by Darrieus and Schoops (*vide Chemiker Centralblad*, 1895, No. 1, p. 522), and he expresses his opinion that this hypothesis is not tenable, his chief argument being that lead dioxide is only formed by persulphuric acid in nearly alkaline solutions.

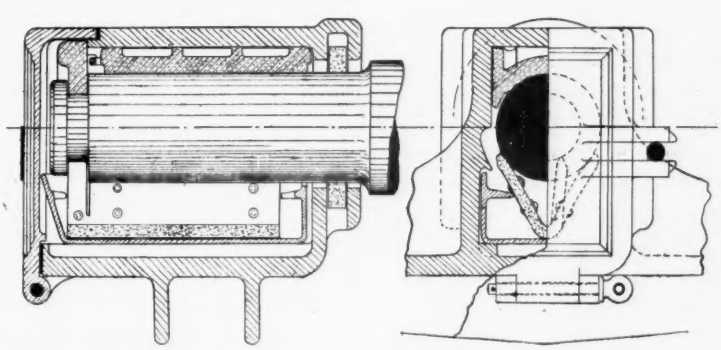
BRUSSELS ELECTRIC TRAMWAYS.

By ERNEST KILBURN SCOTT, A.I.E.E.

One of the electric routes runs around the Boulevards from the Gare du Midi to the Gare du Nord, and the other from the city right out to the country. A good deal of the double track is on one side of the street, with the inner rail close up to the kerb, and where this is the case, tubular poles on one side only, with single-bracket arms about 15 feet long, carry the two trolley wires. Where the tracks are in the centre of the road, span wires attached to poles on each side carry the trolley wires; and if the road is fairly narrow, and there are houses on each side, the span wire is simply fixed to the buildings on either side by ornamental rosettes.

These rosettes cost only about 25s. to 30s. each, and as they bring the cost per yard run of track down to about one-half of what it is when poles are required, the company prefer to use them whenever they can get the householder's permission. Blocks of rubber are inserted between the end of the span wire and the metal of the rosette in order to prevent the humming noise characteristic of the trolley wire from being transferred to the houses. When there are trees, as is the case along the principal Boulevards, the overhead wiring is hardly visible.

The trolley pole is of the usual fishing rod pattern, with grooved wheels and vertical movement only; and where it is necessary to change over from the overhead on to the conduit, or from one line to another, men are stationed with long bamboo poles to move the wheel. The trolley wire being of the dumb-bell section, the trolley wheel has a clear course of uniform section, and consequently jumping the wire is reduced to a minimum.



Axle Box.

Each motor car is fitted with two G.E. 800 25-H.P. motors which give a total horizontal effort of 1,600 lbs. on the 33-inch car wheel when running at 8 miles an hour. The motors are steel-clad and waterproof, essential conditions for good tramway service. The weight of each motor complete with gearing and other accessories is 1,700 lbs. The armature is insulated with asbestos so as to be fireproof, and is also treated with a waterproof material, the Eickmeyer coils being wound into slots. The magnet coils are also fireproof and waterproof, the lower coil being also encased in lead to protect it from oil, which is frequently more disastrous to the durability of the coils than moisture. The journal bushes are of gun-metal, with grease-pad lubrication.

The pinion is of cut steel, and the wheel of cast-iron, the ratio of gear being 4·78 to 1; they run in oil-tight gear cases. The motors are carried by what is known as the cross-bar spring suspension, and are carried on cantilever pattern trucks constructed by the Société Anonyme Franco-Belge, of La Croyere, Belgium, the figure showing the construction of the axle-box which is used.

Each motor car is fitted with the well-known Thomson-Houston magnet blow-out K² controller at each end, and when empty it weighs 6¼ tons, and draws an open trailer car weighing 2 tons. There are no top seats, and the cars are divided about midway for the different classes. Cushioned seats are provided for first-class passengers, and the seats of the trailer are of bent wood, smoking being allowed. In addition to the driver and conductor on the car carrying the motor power, a brakesman and conductor are on the trailer, their uniforms being provided by the company. Passengers are allowed to stand outside on the platforms, and in this way the motors may have 50 per cent. overload, the only effect being to slightly reduce the speed when going against gravity. Exact statistics of the receipts are not published, but it has been satisfactorily proved that a motor car and trailer carrying 64 passengers can be worked at the same cost per mile run as the 4-horse car carrying 34 passengers, which they superseded, and that the receipts have been practically doubled. The speed attained varies from 6 miles per hour in the busy centre to 14 miles in the outskirts, and averages 7½ miles, including stoppages. The cars are supposed to stop anywhere to take up passengers; but as a matter of fact they only stop at the fixed stations, which are sufficiently near together not to be inconvenient. The service is very frequent, every 3½ minutes during the busy parts of the day. Each car runs about 80 miles per day, and after 11 P.M. double fares are charged. The minimum fares are 1½d. and 1d. first and second class, a 4-mile run being 3d. and 2½d. respectively.

The rails of girder section weigh 85 lbs. per yard, and are laid on macadam, no cement or concrete being used. Since electric traction has been adopted, they have been completely re-laid. The Union Company, of Berlin, who represent the General Electric Company, of America, equipped the overhead line under a guarantee as to cost of working of 2½d. per car mile (coal is 9s. a ton), but as the cost came out less, they were relieved of their responsibility before the term had expired. The cost of producing the electricity per B.O.T. unit is given as 1·09d., and the cost of equipping the overhead line is stated by Mr. Janssen, the manager, to be:—

£1,400	per mile	for the line proper.
1,150	„	electric apparatus.
2,860	„	engines, cars.
£5,410		

Each motor car costs, with complete equipment, £670; the trailer, £80; and the original cost of the power station was £12,000. The station is well planned, but is not very centrally situated, the furthest point to which current is delivered being nearly five miles away. Five Babcock & Wilcox boilers are installed, and also compressed air machinery for supplying the Westinghouse brakes. One feature of the generating plant is that no accumulators are used, which necessitates about two-fifths of the total power being held in reserve. Accumulator cars have been tried and abandoned, but the management is by no means prejudiced, and they will probably be used again on the combined plan, which is showing such good results.

The electrical tramways at Brussels have recently made considerable extensions to their conduit system, although at the present moment only the cars on the Rue de la Loi, leading to the exhibition, are being worked on this system, owing to the extra generating plant not having been delivered to time. When this extra plant is running (about the end of September), a distance of about 7 miles will be at once turned over to conduit working, the track and conduit being already laid.

The original plant in the central station consisted of the usual Thomson-Houston equipment, namely, five four-pole 550-volt dynamos of 100 kilowatts each, and a five-panel slate switchboard with magnetic circuit-breakers, switches, &c. Since then two exactly similar dynamos (made in Berlin by the Elektricitäts Gesellschaft) have been added. Each dynamo runs at 650 revolutions per minute, occupies a floor space of 6 feet 4 inches × 6 feet 10 inches, and weighs 5·3 tons. It has two swivel self-oiling bearings lined with babbit metal, and the carbon brushes, of which there are eight (two to each pole), measure 2¼ × 2¼ × ⅝ thick. When the machine is standing the brushes are all taken out of the holders, to prevent motoring, the levers and tension springs

being fitted in a manner which allows of this being readily done.

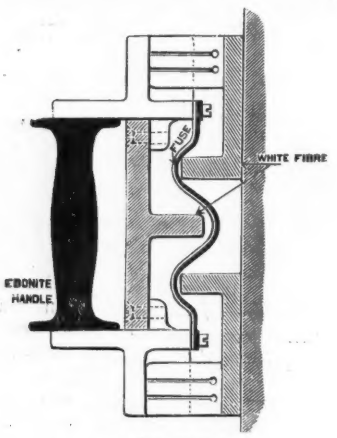
All the dynamos are driven by ropes from McIntosh-Seymour type high speed horizontal engines fitted with fly-wheel governors, and supplied by Ludwig, Loewe & Co.

The more recent extensions, however, altogether swamp the original plant, consisting as they do of two direct coupled engines and dynamos giving 1,200 horse-power each, and two to give 550 horse-power each, or together with the seven rope-driven dynamos the station will have a capacity of 4,500 horse-power.

The new engines are by the well-known firm of Kirchove, of Ghent, and they are fitted with a modified form of Corliss valve gear known as the Corliss-Bonjour. They are an exceptionally fine piece of design and workmanship, and would do credit to the best engine builders in this country.

The dynamos have eight poles, and were designed by Pieper, of Liège. They are each fitted with two massive oil ring bearings, and are connected to the crank shafts of the engines by flexible couplings. There are eight sets of carbon brushes carried on a massive brush holder ring with worm wheel adjustment. The armatures are slotted for rectangular section conductors, spaces $\frac{3}{8}$ inch wide being left every $2\frac{1}{2}$ inches along the core for ventilation. The winding is that which has come to be generally known as barrel winding, and in the case of the two larger machines the coils are being put on in position.

The switchboard has a very handsome appearence. It has been made by the Elektricitäts Gesellschaft, of Berlin, and consists of 16 marble panels, seven of which are the positives and two the negative, for the conduit system. Magnetic circuit breakers similar to the Thomson-Houston are fitted at the top of the panels, and there is the usual complement of meters and regulating switches, the contacts for the latter being at the back of the panel instead of the front. The main switches are single pole of a very simple design but with exceptionally quick break. The fuses shown in the figure consist of tinlead strip bent in and out of bridges of white fibre, these corrugations effectually preventing an arc being formed.



Chopper contact.

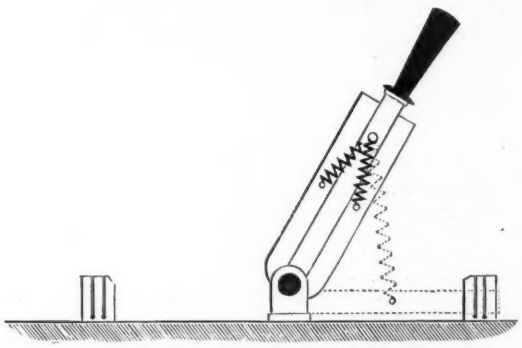
Main Fuse in Switchboard.

On account of the expense, the Brussels Tramway Company of course prefer the overhead wire, and are only laying down the conduit on the Rue de la Loi and other principal streets, because the municipal authorities will not allow the other system.

The conduit, designed and laid down by the Union Company, of Berlin, is a fine piece of civil engineering work. It lies under the near side rail, and has a slot $1\frac{3}{8}$-inch wide; this figure seems high, but when one comes to actually see it on the road, it does not look very extraordinary. The engineers have evidently thought it best not to run risks by working with too fine a margin, in view of the fact that the traffic is always tending to close the slot, and the difficulty that there is in keeping the contact ploughs thoroughly insulated. Another point in favour of a decent sized slot is that the cleaning tools can be worked more freely, and the proper scavenging of a conduit is just one of those items which goes very far to make or mar the success of the system. It has been suggested that bicycle wheels might get caught, but the service of cars is so frequent that no one ever thinks of riding alongside the slot rail—it would be too dangerous—besides, why should they, when there is all the rest of the roadway for their use?

The construction of the conduit is somewhat similar to that at Buda Pesth and Berlin. Cast-iron yokes are placed 3 feet 6 inches apart, along the top of which are fixed, by wrought-iron brackets, a pair of "Haarman" rails, being practically flat-bottomed rails with the foot, or bearing surface, all on one side. The general body of the tube is formed in three different ways—*first*, Portland cement concrete is formed round moulds, which are removed as the mass becomes hard; *second*, concrete blocks are brought on the ground ready to be fixed in position, two blocks, one on each side, going to make up the tube; and, *third*, the tube is built up of brick-work, this latter being adopted when there is any deviation from the standard section, and for the drainage pits, which are constructed at intervals of 45 yards. Where gas and water pipes cross the conduit they are protected with wood. The insulators are suspended from the top of the conduit, and the cavities in which they are suspended are not covered by a movable lid, so that the pavement must be taken up to get access to them. This seems to be the weakest part of the system, which is otherwise well worked out, the contractors (Union Electric Company, of Berlin) giving a guarantee of working for two years, with the liability of having to restore the streets to their former state if the conduit is not satisfactory at end of that time.

The electric conductors are double, and consist of two rolled iron joists weighing 20 lbs. per yard, one for the outgoing and the other for the return, so that the ordinary rails do not form part of the circuit; electrolysis troubles are, therefore, entirely averted. Experience has also shown that snow and sleet will affect the working of the overhead system more than a conduit fitted with two independent electrical conductors, because in the first named there is liability of bad contact between the wheels and the rails. The iron joists are bonded with copper strip, and the flat parts face each other, the collectors or ploughs, two to each car, passing between them. The collectors are thickly insulated with composition where they pass through the slot, and carry at their lower ends bow-shaped flaps of brass pressed against the joists by means of springs. At the places where the conduit ceases and the overhead begins, the collectors are lifted out by means of a winch, or automatically whilst the car is in motion by an inclined plane, which pushes up the collectors. The change-over takes about 10 seconds, including the time taken by an attendant in releasing the trolley and placing the wheel on the wire. Wet weather causes an increased leakage, but the dampness of the collector and joists improves the contact, so that the one effect about balances the other; at any rate, it is found that the coal consumption is about the same in wet as in dry weather. The difficulty with mud and dirt depends on the scavenging, and if this is systematically done there is no difficulty; besides, the fewer horses on the roads makes it all the easier.



Throw Over Quick Break Main Switch.

The price at which the conduit service is being carried out is £19,600 per mile of double track, including everything except buildings.

The Brussels Tramway Company have been treated liberally by the municipality, so they can afford to do the thing properly, the concession for one part of the line running for 50 years.

The running is singularly free from interruption, which reflects great credit on M. d'Hoop, the chief engineer, and M. Carl Lechat. The accidents, when they do occur, are motor burn-outs, or broken axles, and sometimes a specimen of misplaced humanity may be shovelled into the safety fender.

THE TRAINING OF ELECTRICAL ENGINEERS IN GERMANY.

Considering the advanced position which Germany has attained in electrical engineering, the following remarks, summarised from a report by G. Schmidt-Ulm, of the Ilmenau Polytechnic, will be of considerable interest to those connected with electro-technical education in this country.

Herr Schmidt-Ulm's report commences with some general remarks on the extent to which specialisation has been nowadays carried in engineering, and considers that even in electrotechnics a choice must be made between machine construction in workshops and the fitting up of installations outside. The prospective electrical engineer having decided whether he is to be a manager of works, or an erector of installations, his course of education will be regulated in accordance with this decision. Taking the young German who has passed through a good primary school (bürgerschule), or obtained a certificate entitling him to a one year military service, how is he to become an electrotechniker? He must first get a thorough practical training in the use of tools, both hand and machine, which must extend over a period of at least three years. During this time the future works manager must pay special attention to the construction of the parts of machines; the future fitter up of installations, on the contrary, must direct his attention to the putting together of the parts of machines, and the erecting of the machinery in the electrical installation. Since a workshop or installation manager must have a wider field of view than the ordinary workman, this course of practical training must be followed by a course of theoretical training. The theoretical training must not go very deep into theory; but besides a good foundation in making calculations, clear ideas of the working of machines must be imparted to the pupil, his technical imagination should be cultivated, and he should be taught to understand a drawing. In a school for works managers, the elements only of machine construction and electrotechnics should be taught. Great importance should be attached to the teaching of drawing, since by this means the inventive faculty and the understanding of drawings is sharpened. In the experience of the Schmidt-Ulm, the drawing of finished machines is not sufficient, the simple details of the machines must also be dealt with. The electrotechniker must, of course, learn to draw electrical machinery. In order to shorten the theoretical training, which must not exceed two terms of six months, the instruction in general machine construction may be shortened, to give the student time to attend lectures on electrotechnics. In the first term, these lectures must include the fundamental laws and phenomena of electricity, and, in the second term, a descriptive survey of the whole region of electrotechnics. After having finished the theoretical course of instruction, the student will not find it difficult to obtain a situation as assistant manager of works, or assistant manager in installation work, where he can wait his opportunity of being promoted to full management. He will not have to wait long for such an opportunity, since for such qualifications as he now possesses there is always a great demand.

Those who have the means of obtaining a longer theoretical training may aspire to higher posts, as an engineer on the office staff, or in charge of a working installation, or as a designer, &c. Also in these cases it is useful to have as much practical training as possible, but the theoretical must always claim the longest time, and the practical training must of necessity be limited to two, or even one year. Less than one year is not to be recommended. It is not necessary, in this case, for the pupil to become a skilled handicraftsman; all he wants to know is how the different parts of the machines are made and how they work, to enable him afterwards to design in the drawing office. A moderately-sized workshop offers the best opportunities for this kind of training, because the division of labour is carried too far in the larger factories. Practise in a general engineering workshop will be sufficient, in this case, since special electrotechnical operations such as armature winding can easily be learned afterwards. The practical training is followed by the theoretical, and for this latter four or five terms of six months are necessary. The foundation of this course must be machine construction, and after this must come electrotechnics as a special branch of study. It is, however, altogether a mistake to tack one or two terms of exclusive electrotechnical instruction on to a previous course of general machine construction. The electrotechnical instruction must commence in the first term, and advance side by side with the instruction in general machine construction. The object of this is to allow the pupil plenty of time to assimilate the new ideas that are presented to him in electrotechnics, and to keep up his enthusism from the first by instruction in the subject in which he is most interested.

Great importance must be given to the design of machinery in the training of electrical engineers. In many electrotechnical laboratories this is ignored because the professor is a physicist and not a practical electrician. The system of teaching electrical engineering by correspondence (recently started in Germany) is described by the writer as perfectly worthless, and he considers that the only success which it has achieved is in getting money out of the pockets of the public.

THE TEST OF A COAL-MINING ELECTRIC POWER PLANT.*

By T. D. PHILLIPS and J. G. SWAIN.

The successful operation of coal-mining machinery by electric power has been an established fact for several years, and yet in so far as is known but little data have been published concerning the behaviour, regulation, and commercial efficiency of electrically-operated mining machines under the conditions of every-day service.

The present article is the outcome of a series of tests made upon the electrical equipment of Shaft No. 1 of the Brazil Block Coal Company, of Brazil, Ind., under the direction of Prof. W. E. Goldsborough, and with the assistance and co-operation of Mr. James H. McClelland, superintendent of the mines.

The tests are in every sense representative of the daily service rendered by the machinery, as the usual running conditions, during both the tests of the generating plant and of the coal cutters, were not modified in the least by the preparation for the tests, or for the adjustment of the instruments.

The plant tested is located on the north-western edge of the City of Brazil. Scattered through the Indiana coal fields the company has several other mines, four of which they are at present working. Besides their No. 1 mine, they also operate their No. 8 mine by electric power.

The Indiana coal field covers about 7,000 square miles, or one-fifth the area of the State. This area is mainly in the western and south-western part of the State, and ranges in width from 10 to 60 miles. In length it extends from Warren County southward 150 miles to the Ohio River, where it reaches its widest part.

Workable veins are found in 19 counties, and their outcrops occur in three additional ones. At least seven distinct veins of workable thickness occur in the State, varying from about 3 feet to 11 feet, and in a few places from 25 to 28 feet.

The area of greatest development of seams is embraced in the counties of Clay, Sullivan, Green, Pike and Daviess,

* An abstract of a thesis presented to the Faculty of Purdue University, Lafayette, Ind., for the degree of Bachelor of Science in Electrical Engineering, June, 1897.—*Electrical World*, N.Y.

though several others, namely, Park, Vermillion, Vigo, Owen, Warwick and Spencer, rank as close seconds.

The coals of the State are of two varieties, which in places merge into one another. These are the non-caking or block coal, and the caking or bituminous coal.

The former, which is one of the most valuable fuels found in the United States, has a laminated structure, and in the direction of the bedding lines splits readily into thin sheets, but breaks with difficulty in the opposite direction. It can be mined in blocks as large as it is convenient to handle, whence its common name block coal. As a rule, it is remarkably free from sulphur and phosphorus, though in some localities sulphur is found to a large extent.

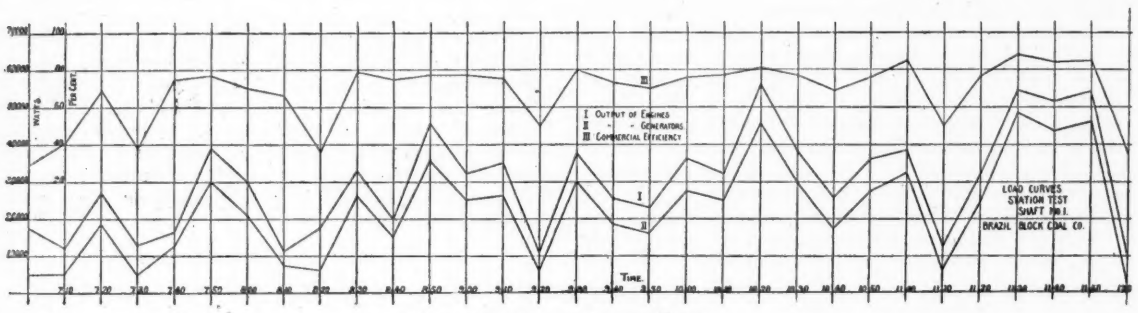
When burning it does not swell, nor does it form a cake by running together; it leaves no clinkers, the only residue after combustion being a small quantity of white ashes. On account of its freedom from sulphur and phosphorus, and its non-caking properties, it can be used without coking, and thus becomes a most valuable fuel for the iron foundry's cupola and the blast furnace.

grinder, and also a small blower for use at the forges; one in the hoisting room, which is geared to a large hoisting drum, around which pass the cables used in raising and lowering the cages. The last is a reversing engine with a very long stroke, made by the Atlas Engine Company, Indianapolis, Ind. It is prized very highly by the Brazil Block Coal Company, as it bears the distinction of being the second engine ever built at the Atlas Engine Works.

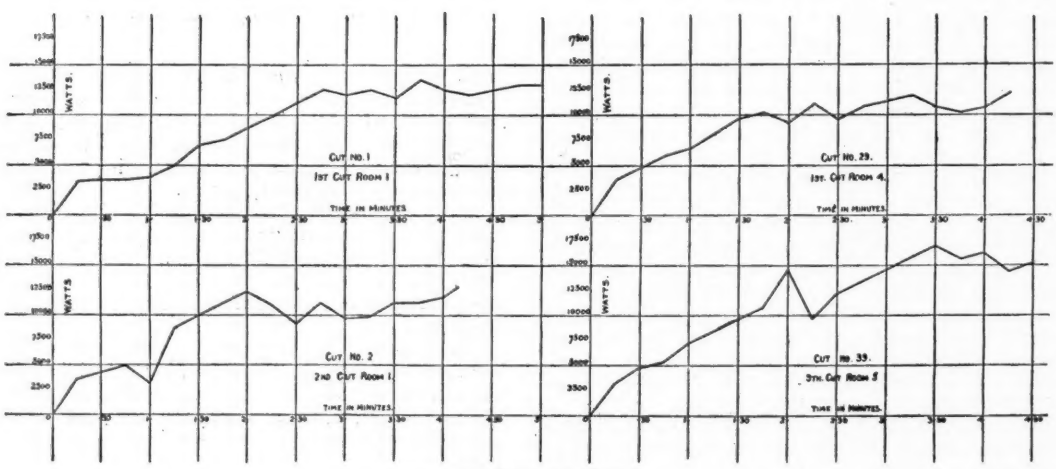
In the power room are two high-speed Ball engines which are rated to give 120 horse-power each under a steam pressure of 90 lbs. These engines are belted to two power generators, supplying power to the coal-cutting machinery in the mine.

Of the pumps, three are in the mine, as are also the two injectors. Two of the pumps are of the Dean Brothers' make, while the other is a Blake. These pumps are operated continually to keep out the water, which rises very rapidly in the mine.

As the tests did not include anything but the operation of two of the engines, the generators, and the coal-cutting



Load Curves from Station Test.



Curves from Machine Tests.

At Shaft No. 1 the working force consists of 120 men, which includes loaders, drivers, track layers, powder men, engineers, firemen, blacksmiths, teamsters, scale men, machine men, helpers, &c.

The plant at this shaft is housed in several buildings, the largest of which contains the tipple and loading chutes, and is directly over the shaft. Besides this there are the blacksmith shop and fan house, and also the power house, in which are located the boilers, engines, generators, &c.

The steam plant consists of two boilers of the tubular type, having a rated capacity of 150 horse-power each. They were built by the Erie City Iron Works, Erie, Pa. These boilers supply steam to five engines, four pumps and two injectors, and are kept in continuous service day and night.

The engine equipment consists of one engine in the fan house, direct connected to a large fan, both having been made by Crawford & McCrimmon, Brazil, Ind.; one in the blacksmith shop, which drives a drill press and emery

machinery, the rest of the apparatus will not be described in detail, except where it bears a direct relation to the work performed.

The two engines previously mentioned were built by the Ball Engine Company, Erie, Pa., and have 12 × 14 inch cylinders. They are bolted to brick foundations. These engines are of the single-valve type, cutting off at about one-quarter stroke. Both run non-condensing, but as the exhaust pipes run underground for about 120 feet to a small ravine, they act somewhat like condensers. The steam before entering the cylinders passes through a separator.

To the two engines just described are belted two direct-current Walker generators. These are rated at 75 kw., and are compounded for 250 volts. They are four-pole machines, having armatures of the ring type, upon which are placed drum windings.

The switchboard, built by the Cutler & Hammer Manufacturing Company, Chicago, Ill., is made of one panel of

ordinary black slate, and upon it are placed the necessary instruments, switches, &c.

The mining machines are Morgan & Gardner coal cutters. These machines consist of an outside framework or bed, upon which moves the sliding frame. This frame is made of channel iron, and the endless chain which it carries fits in the channel. At regular intervals the chain carries small steel bits, which do the cutting. The chain is carried around three sprockets, one at each corner on the head, and one on the motor carriage.

The motor armature stands in a vertical position, and to the lower end of its shaft is attached a gear. This gear meshes with another one on the sprocket shaft, causing the chain to revolve when the motor is started. By means of a worm and a rack on the bed, the motor carriage and sliding frame are automatically fed forward; and as they are advanced, the bits on the moving chain strike against and cut into the coal.

The bed frame is provided with two jacks for holding it solid, one in front, which rests against the face of the coal, the other in the rear, which fastens into the roof.

The machine weighs 2,400 lbs., and its total depth of cut is 6 feet. The manufacturers claim it will cut the full depth in 4½ minutes, and run back in 45 seconds; and that this can be lessened to 3½ minutes, and back in 30 seconds, under favourable conditions.

The machine is rated as follows:—Travel of chain = 273 feet per minute; revolutions per minute of armature = 750, with 220 volts at machine.

The chain is of the up, down, and centre link style. All bits are straight, and of the same length. With a 6-foot undercut there are 48 links in the chain, each link holding one bit. These bits are ½ × ¾-inch in section, and are spaced 5 inches apart on the chain.

The sliding frame has two girders running full length down its centre. These run through openings in the end support, and keep the frame straight; they also act as a stiffening brace.

The total length of a 6-foot undercutting machine is 10 feet over all. The width across the machine at the cutter head is 42 inches over chain, and 45 inches over bits. This gives a full 42-inch cut after allowing a 3-inch lamp into other cuts.

All material used in the construction is either cast-steel or wrought-iron. All gears are steel, and are cut out of solid masses of metal. The shunt motor used on the machine is of the four-pole type, with two field windings. It has a capacity of about 20 horse-power. The machine can be readily loaded on a truck.

The station test was made March 16th, 1897, and lasted for a complete working day of nine hours. The start was made at 7 a.m. and finished at 4.30 p.m., with a stop from 12 to 12.30 p.m.

The test consisted of taking indicator cards from the engines, noting their speed and the steam pressure, measuring the current in the main line, the voltage, and the current in the shunt field windings of the generators.

As both machines are continually operated on the same circuit, and are exact duplicates of each other, the test was made with both working together, and not separately. All the instruments used came from the laboratory of Purdue University, and were in good working order. The electrical instruments were calibrated shortly before the test.

The reducing motions used on the engines were of the pendulum type; one end being fastened to the rafters of the roof, the other end was slotted to receive a pin; and the pin was screwed into the cross head. All electrical instruments were read every two minutes, while the other readings were taken every 10 minutes.

Indicator cards were taken from each end of both cylinders simultaneously. They disclosed the fact that in the case of both engines much more work was done in the crank end than in the head end of the cylinders. This was especially noticeable in engine B, where the crank end did two and often three times as much work as the head end. This fault was due to the fact that the valves were poorly adjusted.

One very bad fault was discovered at the close of the test. Upon removing the top of the steam chest on engine B, the exhaust ports were found to be very badly choked by the steam packing, which had worked in from the stuffing box.

As to speed regulation, neither engine did well, due, no doubt, to the faulty action of the governors, which were not properly set for the load they had to carry.

Both engines worked under the disadvantage of having a load very much smaller than their rated capacity, which brought down correspondingly their commercial efficiency. This also applies to the generators, which, together, have a capacity of about 600 amperes, but as the circuit breaker flies out at 300 amperes, they cannot work at more than half load. A friction test, with belts on and off, was made on each engine.

An inspection of the load curves shows that where the load fluctuation is very great there is a corresponding change in the efficiency curve, though in some places, where the load varies a good deal, the efficiency remains fairly constant.

The output of the generators (curve No. 11) is plotted with readings taken at times corresponding to the times indicator cards were taken from the engines.

There is also plotted a total load curve where the readings are taken every two minutes. This curve shows the actual variation of the current between the readings of the indicated load.

Throughout the test the voltage remained practically constant, varying between 245 and 255 volts. In many instances the current would rise to almost its maximum of 300 amperes, and then drop to nearly zero. There is always a constant load on the station of from 15 to 20 amperes, due to incandescent lights and leakage. The majority of these lights are at the bottom of the shaft, and are kept burning continually.

The amount of coal hoisted during the week of the test, which represents the work done by the machines, varied from 266 tons to 300 tons per day, depending on the number of machines working. An average of the output was 284 tons per day.

By integrating the total load curve of the generators, we find the average output in watts was 21,750, or 689 watt-hours per ton of coal.

By taking an average of the calculations found in the tables, the following results of the test are obtained: engine efficiency 0·69, generator efficiency (commercial) 0·69, station efficiency 0·48.

These results, though low, are as good as could be expected, when the load placed upon the station is taken into account.

The test on one of the coal-cutting machines was made March 17th, 1897, and consisted in measuring the power absorbed and the work performed. This was done by measuring the current and voltage, the depth of cut, the height of vein, width of cut, and time of cutting. Each machine is operated by one man and a helper; but when moving from room to room they have the assistance of the loaders, and also of a driver and a mule.

The main conductors are strung along the entries of the mine, the positive being heavily insulated, while the negative is bare. With each machine there is a cable from 50 to 100 feet in length, wound on a reel. One end is fastened to the reel, the other being strung out and hooked on to the mains. From the reel runs another short cable, which connects with the machine.

The test was run under conditions fairly favourable to the machine. All the cuts were in rooms, and but little time was lost in moving. That the instruments might be kept out of the way of the men in moving, they were connected in the circuit at the reel.

The number of cuts made during a day by one machine depends on the condition of the mine and the nature of the cuts, whether room or entry cuts. If entry cuts are made, it necessitates the moving of the machine from point to point, causing much loss in time. The machine tested has made as high as 72 cuts in one day; this, however, is a very unusual record.

A study of the curves given herewith will show a few interesting points regarding the operation of electric coal cutters. The quality of the coal, whether hard or soft, has a great deal to do with the amount of power absorbed. One feature common to all cuts was that the power necessary to operate the machine increases with the depth of cut. In some cases the power reached its maximum before the end of the cut; in most cases, however, the power did not rise to its highest value until the end was reached. As a rule, the first cut made in a room requires more power than the succeeding ones, due to the fact that the machine cuts on

three sides on the first cut, while on the others it cuts on only two. An illustration of this point may be seen by comparing the curves of cuts 1 and 2 in room 1.

One of the heaviest cuts made during the test was No. 39, which was the ninth cut in the fifth room. The heaviness of this cut was due to the hardness of the coal.

The variation of power during a cut may be attributed to several causes. If the braces or jacks on the machine slip to any extent, and they often do, the power drops for an instant until the cutter again strikes the coal. The slack which accumulates as the depth of cut increases resists the action of the machine and should be kept out of the way at all times. Some of the bits may be sharper than the others, and when the sharp bits strike the coal there is a less expenditure of power.

The power required for an entry cut may be seen by referring to the curve of cut No. 17. This also shows that the power often reaches a maximum before the end of the cut.

Cut No. 14 required the most power. It was made in the direction of a "horse back," or where the vein gets very shallow.

The bits on the machine are changed about every 15 cuts. The average time of making a cut is 4 minutes and 15 seconds, and 1 minute to run back. It requires about 15 amperes at the start to overcome the friction of the machine.

The maximum current at any time was 72 amperes, caused no doubt by the bits striking a hard spot in the coal, with excessive friction in the machine, due to the slack, &c. The average power consumption during a cut was 9,963 watts.

Arrangements were made with the weigh boss, whereby each car loaded from where the machine worked would be marked. In this manner the exact amount of coal cut by the machine and hoisted could be determined.

The amount hoisted from cuts made by the machine tested was 44·3 tons. Adding to this the one-fifth which goes through the screen, we get 44·3 + 8·86 = 53·16 tons, or an average of 1·33 tons per cut.

From the above it will be seen that it takes an expenditure of 9,963 watts per cut, and the average time of cutting is 4 minutes 15 seconds, or ·07 hours, from which it is readily seen that 524·4 watt hours per ton are required.

This result corresponds very closely to the calculation made on a previous page, where the expenditure per ton was found to be 689 watt-hours. The difference between the two is due to the lamps, leakage, &c.

Although the machine is built for a 6-foot undercut, it is practically impossible for it to do this, owing to the fact that the front jack takes up some space, and the face of the coal is in places very uneven. The thickness of the vein was taken at an average of 3 feet above the bits of the machine. The tonnage per cut as calculated is made on a basis of 77 lbs. per cubic foot.

These calculations give an average of 1·7 tons per cut, while by weight it is 1·33 tons per cut. The difference, ·37 tons, approximates the slack, &c., that is not loaded.

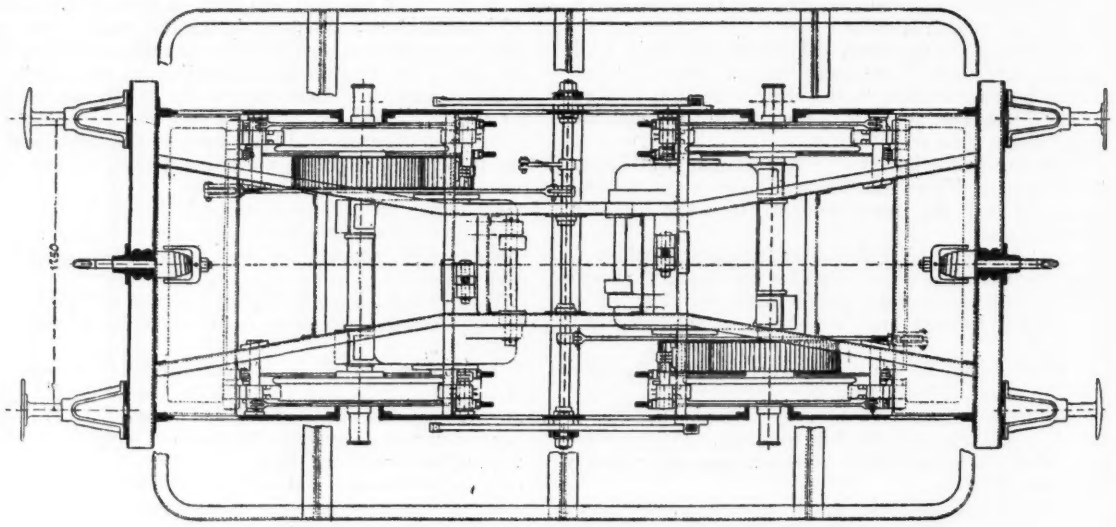
If 2½ tons represent the work done per day by one man with a pick, it will be seen than one machine does the work of about 20 men. This fact alone shows a great saving in expense.

In conclusion, it may be said that the machine as tested gave good results. It is well adapted to the nature of the coal, does its work well, and seems fully able to withstand the heavy strains placed upon it.

The Brazil Block Coal Company were the first to adopt the use of electrical machinery in the mines in the block coal region. Their success has been in advance of their expectations, and, without doubt, other companies will soon instal apparatus of a similar nature.

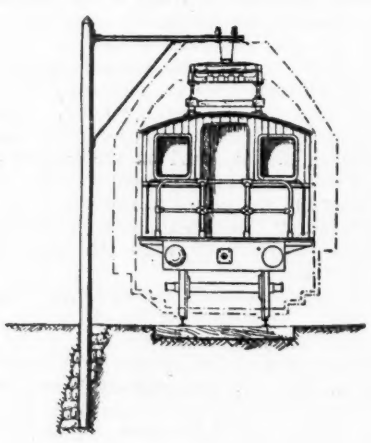
AN ELECTRIC RAILWAY LOCOMOTIVE.

The Allgemeine Elektricitäts-Gesellschaft, Berlin, has recently constructed an electric locomotive adapted to be used on ordinary railways for shunting and other miscellaneous work. It is built for the normal gauge of 1,435 mm., and

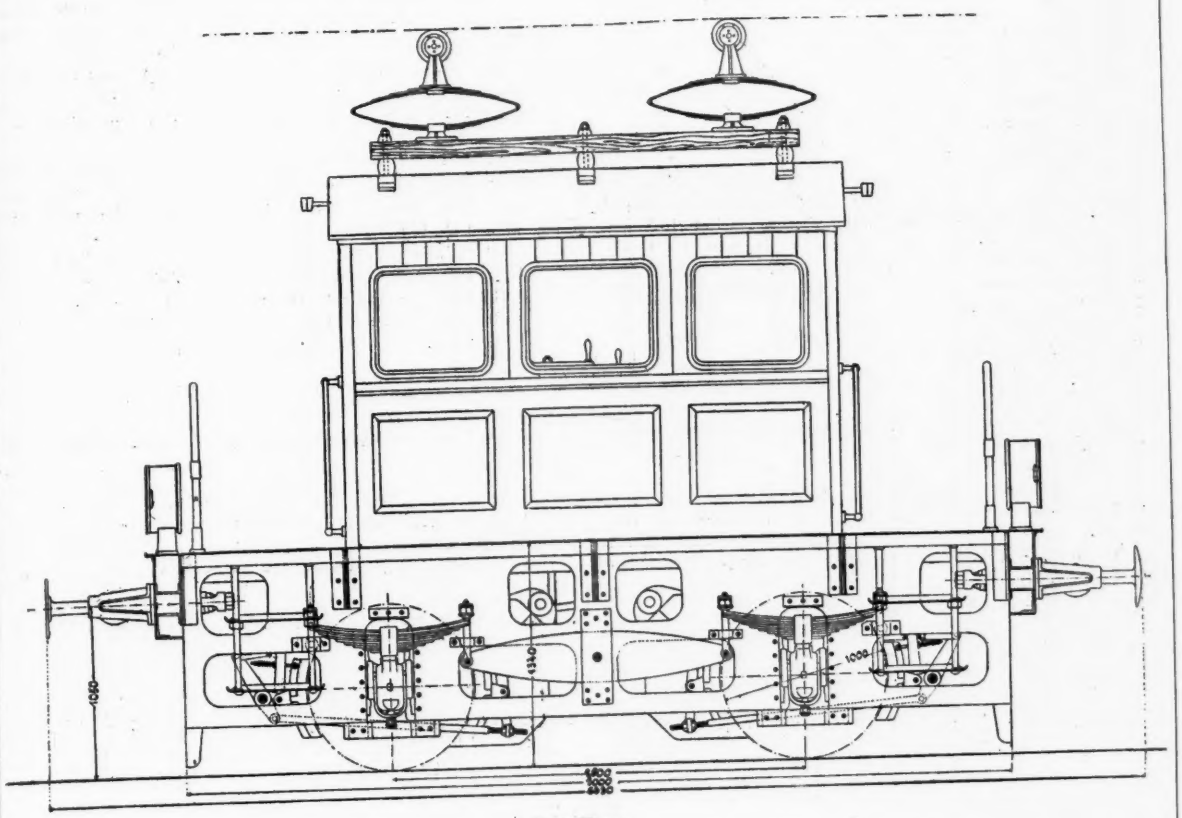


An Electric Railway Locomotive.—Plan.

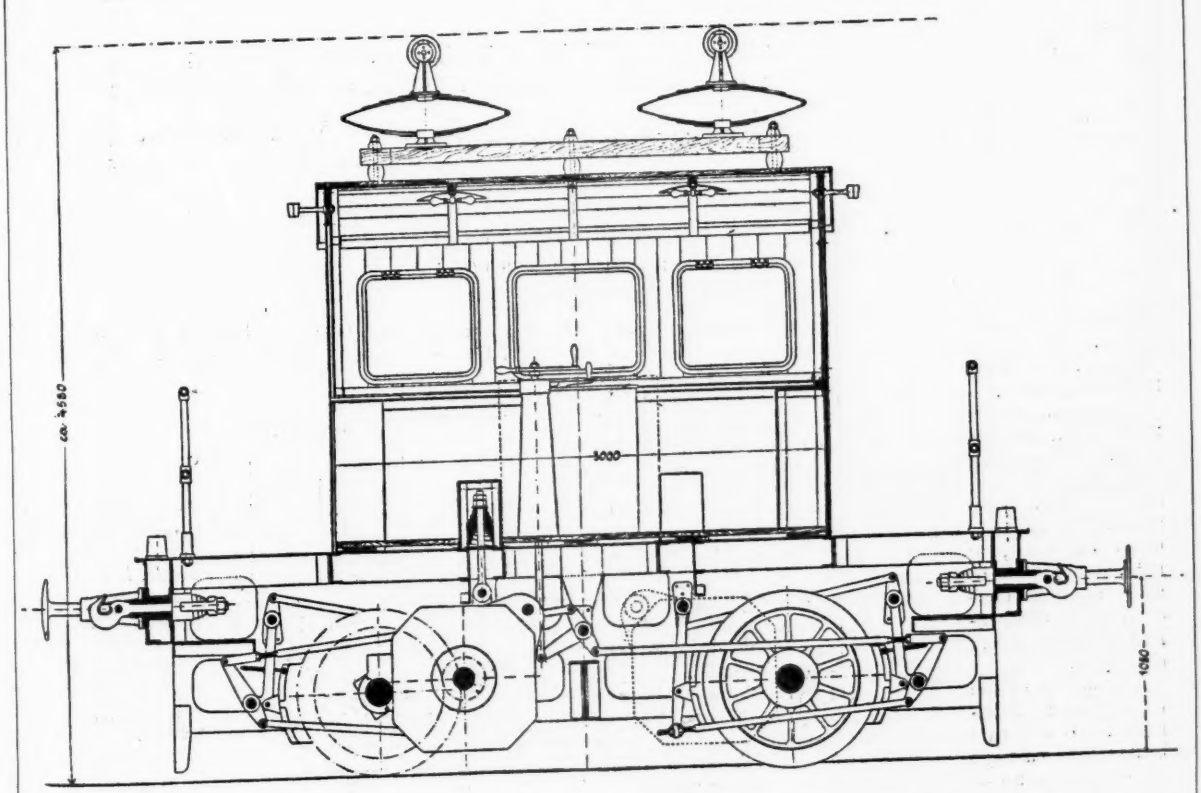
is completely symmetrical. It has two axes, each of which is driven by a motor. In its design, the rules laid down



for rolling stock on the German railways have been observed. It can thus be taken as a carriage in an ordinary train, when



Side View.



Longitudinal Section.

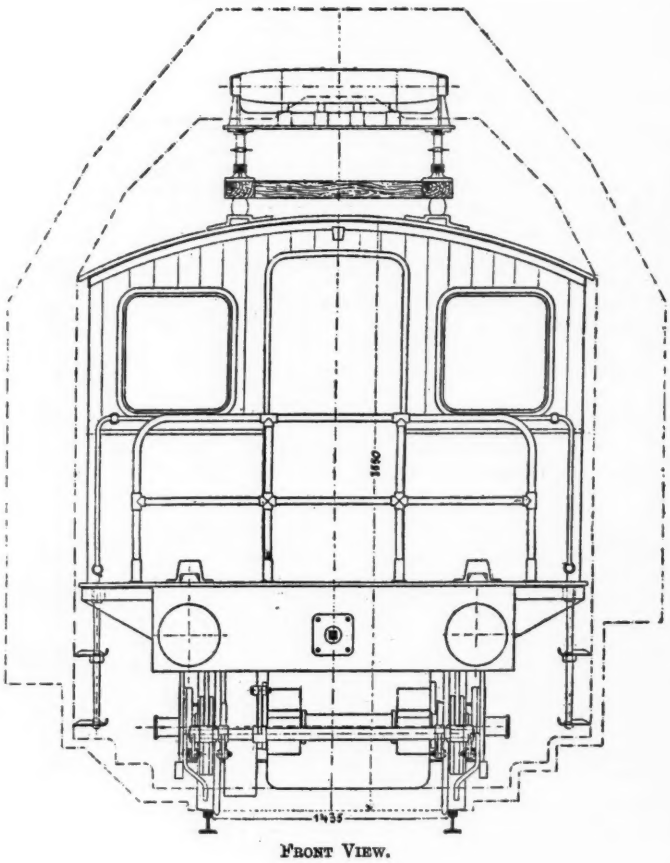
the appliance for taking off the current has been removed, which can be done without disturbing the other parts.

The locomotive is able to draw a train weighing 120,000 kg. at a speed of 30 miles an hour on a level track. For this purpose the total weight of the locomotive must amount to about 20,000 kg., and the weight is made up by filling certain boxes with sand or other ballast. The locomotive is made entirely of iron and steel with the exception of the upper part of the cab or driver's house.

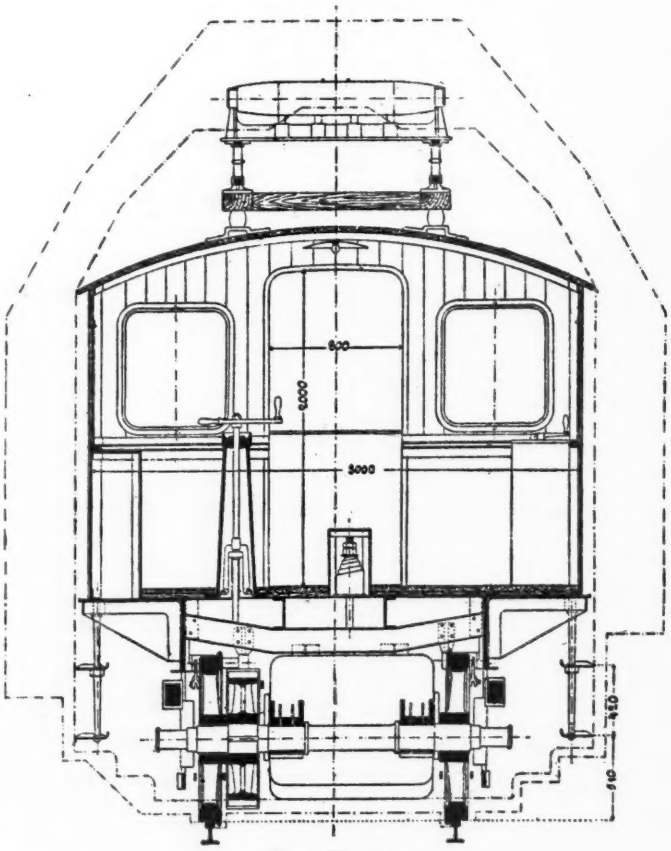
The under-carriage consists essentially of two longitudinal girders made of iron plates strengthened with channel iron, and carrying at each end the buffers and guard irons. The latter reach down to within 60 mm. of the rails, the normal height of the buffers being 1,050 mm. For connecting the locomotive with the train, a hook is fitted in each end bar of the frame, the tail rod of which is fitted with a buffer spring. The principal frame plates are provided with brackets to support the upper box. The whole under-carriage is covered with iron plates, those for the platform being roughened on the service. Slots are cut in the frame plates for the axle boxes.

The wheel space is 2,500 mm., so that curves of the smallest permissible radius can be easily negotiated. The diameter of the wheels is 1,000 mm., and they can be made of solid cast-steel, or of wrought-iron with spokes and steel tyres.

The weight of the locomotive is transmitted to the axle boxes by carriage springs made up of single steel plates 90 mm. broad and 13 mm. thick, held together at the centre by a band. Balancing bars are used to distribute the weight uniformly on the springs. The spring suspending rods are furnished with nuts, by which the height of the buffers can always be regulated.



Front View.



Cross Section.

A brake block is applied to each of the four wheels, and they may be applied in the ordinary way by hand, or air brakes may be used, the pressure-air being supplied by a pump driven by a special electromotor.

For protection against the weather, a cab or driver's house, with a sufficient number of windows, is built in the centre of the under-carriage. At each end of the house is a platform, accessible from the cab through a hinged door. It is 3 metres wide, so that it is possible to see the whole of the train from the locomotive. Each platform is provided with a railway of iron tube. The upper part of the cab is made of wood to make the insulation better, and it contains the electrical arrangements to be described further on, and the mechanism for applying the brake. This is fitted in a cast-iron pillar, and permits the simultaneous application of all the eight brake blocks. Under the windows are the ballast chests, as well as a cupboard for holding the necessary tools, &c. The locomotive is provided with a whistle worked by pressure-air, supplied by a hand pump.

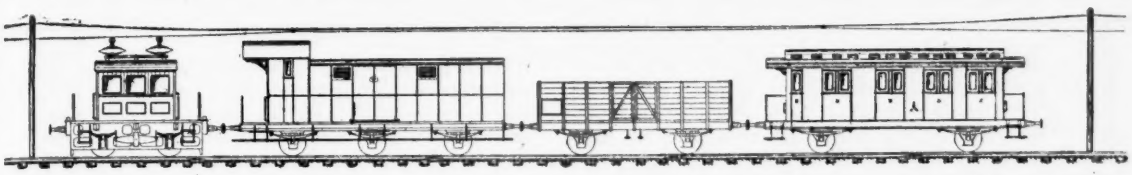
The floor of the cab is covered with wood, and is fitted with trap doors to give access to the machinery for lubrication, &c.

Supports for two paraffin signal lamps are provided on the end walls of the cab, in case of any special reason for signalling arising.

The electric energy is supplied to the locomotive by an overhead conductor, the current being taken off from this by bronze rollers supported on coach springs which press the rollers vertically up against the conductor. The ordinary trolley pole cannot be applied in

this case on account of the frequent changes of direction; neither can the Siemens contact bow, because at high speeds it consumes a considerable amount of power. The central rail cannot be used on account of the insulation difficulties and the difficulty in passing points.

In order to obtain a sufficiently good contact between the overhead conductor and the rollers which take off the current, pliable, *i.e.*, thin wires must be used. For this reason, the overhead conductor consists of two wires, 150 mm. apart in the same horizontal plane, each wire being of hard copper and 8 mm. in diameter; the wires are not insulated from one another. The conductor is suspended from special



wire ropes in such a way that its lowest point is 4,430 mm. from the surface of the rails. It is, everywhere, therefore, 4,430 − 4,280 = 150 mm. above the limiting height allowed for rolling stock. To support the overhead conductor, wooden or iron posts with brackets are fixed at distances of 40 to 80 metres apart along the railway. The bracket is 4,800 mm. above the rails, and, therefore, stands clear of the highest rolling stock. Each bracket carries two porcelain insulators, upon which the afore-mentioned wire rope is supported; the latter can, therefore, be used as a feeder. The return current passes through the rails, which are bonded, and where necessary connected to a special return conductor.

The locomotive has two motors of the normal type used by the A.E.G. for ordinary railways. Each motor is supported at one side by a bearing resting on the wheel axle, and at the other side by a spring on the under-carriage, in such a way that only one-eighth of the weight of the motor rests uncushioned on the wheel axle. The wheel axles are driven from the motors by toothed gearing, having a velocity ratio of 1 : 3. The pinion on the armature shaft is phosphor bronze, and the two-part wheel on the wheel axle is cast-steel. To reduce the noise, the teeth of the gearing are made oblique or stepped by a special machine. The wheels are enclosed in a gear case of sheet-iron.

The motors are series motors, and the magnet frame is a steel casting, shaped to act as a casing, and to carry the bearings of the armature and the wheel axle. The motor casing is made in two parts, and protects the motor from moisture and dust, while permitting easy access to the interior parts. Special doors are made to give access to the commutator. The coils of the armature are wound on spools which are pressed into slots in the armature and carefully fastened. Many simple repairs can thus be carried out by unskilled workmen. It is possible to remove the motors from underneath without raising the locomotive or disturbing the cab. The normal number of revolutions of the motor is about 840 per minute, with a pressure of 500 volts.

On one of the side walls inside the cab the switch is fixed, and it is so arranged that it can be set for backward or forward motion. For this purpose, the switch has two crank handles; one of these is used entirely to regulate the speed, while the other is merely a current reverser, by means of which the current (and consequently the direction of motion of the locomotive) can be reversed, or completely shut off. In the latter position a resistance is thrown into circuit with the motors, which then act as generators, and exercise a powerful and economical braking action, a device which has been patented by the A.E.G. When the locomotive stops, the handles may be taken off, which causes the contact rollers to be pulled off the conductor, and prevents unauthorised use of the locomotive.

Variations in the speed are obtained by different arrangements of the motors, and by changing the strength of the magnetic field. For the lower speeds the motors are arranged in series, and for the higher speeds in parallel. As compared with the system of regulating the speed by resistances, this system results in a great economy of energy. It is claimed that the A.E.G. arrangement consumes only the amount of energy required for the traction. A resistance is, however, interposed at starting, in order to start the train without jerks. But as soon as the motor is under way, this resistance is thrown out, and further unnecessary loss is got rid of. This resistance is placed in the centre of the cab, in a box of perforated sheet iron.

The normal consumption of current at 500 volts is 110 amperes for each motor. Each motor develops with this current 84 H.P. (H.P. = 736 watts), and is capable of giving a maximum output of 150 H.P.

Besides the electrical fittings already described, the locomotive is also furnished with—1. Safety devices to protect the motors from excessive current; these being placed in an accessible place inside the cab. 2. A lightning protector with a self-acting spark extinguisher in which movable parts liable to rust are avoided. 3. An arrangement for cutting out one of the motors when damaged. 4. The afore-mentioned resistance for obtaining a smooth start, adapted also to be used for the electric brake. 5. An electric lighting outfit with the necessary switches.

The locomotive is lighted with eight electric incandescent lamps, arranged four in series. When the locomotive is used for pulling a train, there are two lanterns alight each with two lamps over the front buffers; when shunting, the lanterns lighted are over one buffer before and one behind. Either arrangement of lanterns may be lighted up simply by setting the switches. There are always four lamps lighted on the ceiling inside the cab. The switches are so arranged that in case of the failure of one circuit with four lamps, the four remaining lamps can be distributed, one in each lantern and two on the ceiling inside the cab.

THE PRECISION OF ELECTRICAL ENGINEERING.*

By FRANCIS B. CROCKER.

There still exists quite a general idea that electricity is so imperfectly understood, that its laws and actions are little more than matters of chance or guesswork. The experience of the electrical engineer is supposed to consist of a series of surprises and shocks to his mind as well as to his body. This notion is not confined to the ignorant, but is believed by many educated persons, even including our brother civil and mechanical engineers; indeed, some members of our own profession hear this opinion expressed so often, that they partly accept it as true, or at least they have no ready arguments with which to refute it.

The existence of this popular error concerning electricity is perfectly natural, and arises from the novelty of the subject and the fact that its development has been so great and so rapid, that no one but a few specialists have been able to keep pace with it.

The subtlety, extreme rapidity of action, and the astonishing achievements of this modern agency make it appear most mysterious and occult in comparison with the ordinary forms of energy, such as heat and mechanical power. Possessing such transcendental powers, it is looked upon as something not only unknown, but unknowable, an irresponsible power for great good or great evil. This idea has sometimes been the cause of actual harm to the progress of electrical engineering. The profession has been considered to be

* Inaugural Address of the President at the 14th general meeting of the American Institute of Electrical Engineers, Eliot, Me., July 26th, 1897.

hardly legitimate, those who practised it being regarded as either wizards or charlatans, or a combination of the two. During the present year, the president of a large steam railroad system, on which electric propulsion is being tried, publicly expressed his opinion that electrical engineers know little or nothing of their subject. In legal decisions in this country and abroad, judges have stated that electricity was so vaguely understood, that testimony concerning it was of no practical value.

It has also been held by many courts that electricity being intangible, has no real existence, so that the tapping of current from the wires could hardly be considered as a theft, except in an imaginary sort of a way. The production of electrical energy in central stations has been decided by metaphysically-inclined judges to be a totally different kind of business from the manufacture of gas. In point of fact, the differences are all in favour of the practical character of electricity. More useful operations can be performed by it; it can be more easily transmitted and distributed; the percentage of leakage is less, and its measurement is far more convenient and accurate.

The idea that "no one knows what electricity is, therefore we know practically nothing about it," is often expressed by those who want to excuse their own ignorance of the subject. They are glad to think that they are are no worse off in this respect than the rest of the world. There deduction is quite natural, but is absolutely fallacious. While we must admit that we do not know the real nature of electricity, the same limitation of knowledge applies to all other fundamental facts. Gravitation is the most familiar of natural phenomena, yet we have no conception whatever of what it actually is. Our theories and mental pictures of the nature of electricity are much more definite than those concerning gravitation. In regard to the latter, little progress has been made since the time of Newton, while electrical knowledge has advanced, and is now advancing with giant strides. There is every reason to believe that we shall "know what electricity is," and be able to explain the inherent mechanism by which electrical actions take place, before we understand how and why a stone is drawn to the earth. What we do know, however, are the laws of both electricity and gravitation, as well as the results that they produce, and it is very doubtful if our ability to control, measure and utilise these agencies would be improved even if we understood their exact nature. The laws and applications of hydraulics would be just as definite and successful, even though the fact were not known, that water is composed of two atoms of hydrogen and one of oxygen. It is possible that methods of generating electricity may be advanced when its real character is discovered; but it is not likely that this knowledge will greatly affect the methods of handling and using it.

The popular ignorance and doubt concerning electricity is rapidly disappearing, in consequence of the remarkable results accomplished by it during the last 10 or 15 years; but it will not be out of place, I think, to consider at this time the remarkable exactness which electrical engineering has reached. A discussion of this question may serve to inform laymen who are not aware of the facts, and may also be a matter of interest and satisfaction to ourselves. This profession has only very recently gained for itself a position of independence and equality among the branches of engineering; but it can now fairly claim to be an example for the others to follow, not only in the magnitude and rapidity of its results, but also in the exactness and certainty of its methods. Let us consider what are the principal facts upon which this strong claim is based.

The names connected with electrical science:—Gilbert, Franklin, Faraday, Ampère, Maxwell, Henry, Helmholtz, Kelvin, and a long list of other distinguished electricians, are not men whose ideas are vague or incorrect. Indeed, it is a significant fact that the ablest and most profound scientific men have been attracted by, and have performed some of their best work in the study of electricity.

The rapid progress of electrical science and its applications is an absolute proof of sure and exact knowledge. Uncertainty would necessarily cause delay, and error would involve repeated trials before success could be reached. The fact that the difficult arts of long distance transmission of power and electric traction have been developed to their present state of importance and success in about 10 years, shows conclusively that electrical theories and designs agree very closely with the actual facts.

The great results accomplished by electrical engineering is probably its strongest claim. Many of these are so unique and astonishing, that we still regard them with wonder even after we have become familiar with them. Among the most striking of these examples are the locating of faults on submarine cables, telephoning a thousand miles or more, transmitting power over 100 miles, sending simultaneously a number of messages on the same wire, utilising the power of Niagara, and producing the Röntgen ray. These and hundreds of other wonderful feats are not accomplished by chance, or by groping in the dark.

The close relationship between pure and applied electrical science is still another proof of the exactness and truth of both. If knowledge were complete, theory and practice would become identical. The agreement between theoretical and practical electricity is largely due to the small losses which occur in electrical apparatus and processes. Even quantities which correspond to friction in mechanics, such as electrical resistance and magnetic hysteresis, are capable of exact calculation. It is only the purely non-electrical factors, such as the friction of bearings and air resistance, that are uncertain in designing electrical machinery. The almost infinite rapidity of electrical action makes the time element so small that it can almost always be neglected. This greatly simplifies calculations and renders their results more accurate. The fact that there is only one kind or quality of electricity also gives definiteness to our ideas and calculations. With coal we must know its quality, including both its physical and chemical properties, in order to make even approximate calculations concerning it. In the case of steam, pressure and volume are not sufficient data; the amount of moisture or superheating must also be known. The most accurate methods of the physicist are not any too good, nor beyond the reach of the electrical engineer, and they are often employed by him. A notable example of this is Lord Kelvin's work in connection with laying the Atlantic cable, which was undertaken at about the same time that he began to publish his essays on the vortex theory of matter. When Werner Siemens first built his self-exciting dynamos, he also constructed the sensitive galvanometers, used in the researches of his friend Helmholtz. It was Siemens, the electrical engineer, who gave his money and influence to the Reichsanstalt, an institution where the most accurate physical work is now being carried on.

A historical example of the agreement between electrical theory and fact is the brilliant work of Ampère, who gave to the world a beautiful and complete theory of electro-magnetism within a few days after he heard of its discovery by Oersted. The work of Maxwell is another great example of the power of the intellect to deal with electrical problems.

Hertz said, in regard to Maxwell's electro-magnetic theory of light: "It is impossible to study this wonderful theory without feeling as if the mathematical equations had an independent life and an intelligence of their own; as if they were wiser than ourselves, indeed, wiser than their discoverer; as if they gave forth more than he had put into them. And this is not altogether impossible; it may happen when the equations prove to be more correct than their discoverer could with certainty have known."

It can hardly be admitted that there is anything in Maxwell's equations that he did not put into them, but the remarkable experimental corroboration of Maxwell's theories many years after they were evolved, shows that from a few fundamental truths almost the whole theory of electricity may be deduced.

This power to solve problems successfully by *à priori* reasoning demonstrates the perfection of electrical science. We can arrive at the facts by reasoning out what they ought to be; hence we may say that electrical science is ideal. In other branches of applied science, as, for example, in civil engineering, the corrections, factors of safety and other allowances are often much greater than the original quantity itself. In such cases it is obviously impossible to go very far from an experimental fact by any process of reasoning. The errors would immediately become so magnified that the truth would be greatly distorted or lost entirely.

To take a concrete example, the losses in transforming electrical energy are only 2 or 3 per cent., and if an error of 10 per cent. is made in calculating these losses, the actual

error is only two- or three-tenths of 1 per cent. It would, therefore, be possible to design a system in which electrical energy was transformed many times, and yet the final error would only be 1 or 2 per cent. If, on the other hand, the losses in mechanical engineering are 10 or 20 per cent., or even 50 per cent., as is often the case, an error of 10 per cent. in calculating these quantities would soon become multiplied to a large figure.

Exactness in electrical units and terms is another strong point of electrical engineering, because definiteness in terms and ideas go hand in hand. The system of electrical units is complete and scientific, being based directly upon the C.G.S. system, and is the only example of a set of units which are universally adopted. The metric system is not in use in the United States, England and her possessions and many other countries, but the same electrical units are accepted by all nations. This avoids the great confusion which arises from the use of several different units for the same thing, as is the case in steam engineering, in which at least four different heat units are commonly employed.

In electrical engineering, the distinction between the various quantities are usually more clearly understood, as, for example, the difference between force, work and power. In other branches these quantities were often confused, and the fact that mistakes of this kind are not more often made at present is largely due to the influence of electrical engineering in the accurate use of terms. The useful word torque has been introduced through electrical engineering, although it is a purely mechanical quantity. The adoption of such terms as impedance and reactance gives a nicety of expression which is rarely found in other applied sciences.

(*To be continued.*)

COST OF ELECTRIC TRACTION.

Our monthly contemporary, the *Railway World*, has for some time past published at regular intervals after the appearance of balance sheets, a critical analysis of working expenses on the electric and cable lines in this country: and the interesting way in which the dry bones of figures and statistics have always been handled in these articles tempts one to think that a hard headed Scotchman is responsible for them. They say that Scotchmen always make the best actuaries and accountants, perhaps because with figures one "jokes wi' deeficulty." There is more room for a dry pawky humour.

In the latest of these articles, just published in the September issue of our contemporary, the author begins by a curious complaint that he finds his occupation temporarily gone, although both cable and electric lines have increased in size, number and importance. Consequently the only accounts which he has to analyse and compare with those of previous periods, are those of the Liverpool Overhead and the City and South London Railways.

No accounts have been published of the Birmingham lines owing to the recent transfer to a new company, and therefore the interesting group of comparisons between horse, steam, cable and electric accumulator (hitherto the unique pride of the Birmingham Central) can no longer be drawn.

Similarly, Edinburgh has bought up the Edinburgh Northern Tramway Company's lines, and separate half-yearly accounts of this very successful cable system no longer appear.

As time goes on, however, our statistical friend will reap a good harvest and have plenty of corn to sift. Within the next year or two, there will be the City and South London extension line to take into account; the Waterloo and City; the Central London; the Baker Street and Waterloo; the Piccadilly Circus and Brompton—all in London itself—whilst for the provinces, we shall have a most complete and elaborate municipal cable plant at Edinburgh; city owned electric lines at Leeds, Sheffield, Liverpool, Halifax, Hull and Blackburn—from all of which may doubtless be derived figures enough to prove that electric traction is cheaper than flying, whilst cable cars cost still less. There will soon be plenty of accounts to analyse.

Those now dealt with are by no means uninteresting. It is a matter for congratulation that the electric railways have brought down their proportion of expenses to receipts to so low a ratio as 63·18 per cent. at Liverpool, and 55·64 on the City and South London.

The Edinburgh cable line also has a good showing, midway between the two, being only 57·72. But the difference between the expensive first cost maintenance and working of railways as compared with that of tramways becomes very clear, when we note that at Liverpool it cost £22,759 to carry 4,269,260 passengers and run 363,399 miles; on the City and South London, in a similar fashion, £15,734 was spent in running 232,703 miles and carrying 3,437,810 passengers. For the previous half-year's working on the Edinburgh cable line, it cost £5,021 only to run 200,235 miles, and carry 2,012,212 persons.

Working these figures out, we have as average passengers per car or train mile:—

	Train mile.
Liverpool	12
City and South London	14
Edinburgh	10

Dividing into the expenses per car or train mile, we get the average cost per passenger carried per mile:—

	Pence.
Liverpool	1·25
City and South London	1·14
Edinburgh	·6

Verily, if railways can be made to pay a good dividend, tramways ought, with equivalent fares, to prove a gold mine.

DR. GUSTAF DE LAVAL'S STEAM TURBINE AND HIGH PRESSURE BOILER.

By J. C. LYELL, A.I.E.E.

Distinctly the greatest engineering novelty at the Stockholm exhibition is the De Laval steam turbine and high pressure boiler. One of the great advantages of the De Laval steam turbine is that as soon as the steam arrives at the turbine wheel it immediately expands to the pressure of the atmosphere, or if working with a condenser to the pressure in it.

The steam is admitted to the nozzles direct from the boiler with which they are connected and expands immediately it leaves them. This obviates all difficulties with regard to the tightening of movable parts against a high steam pressure, and the lubrication of such parts working in steam of high temperature which has hitherto proved an almost insurmountable difficulty.

It is this circumstance also which has made it possible to use to the utmost advantage the energy resulting from steam of great pressure and high temperature.

Dr. De Laval's never ceasing efforts in this direction have at last been crowned with success as proved by the boilers on view at the Exhibition. The different types which have been constructed up to the present time work at a steam pressure of from 50 to 220 atmospheres (725 to 3,190 lbs. to the sq. in.). The first question which will arise will no doubt be, as to the danger from the use of steam at such an enormous pressure. It is a curious fact, therefore, that the danger of explosion is decreased in ratio as the pressure of the steam is increased. This is owing to the construction of the boiler, which not only makes such high pressure possible but also necessary. The steam and water space in the boiler is naturally very small. The boiler consists of a single wrought iron tube of comparatively small diameter wound in concentric spirals, between which the flames rise. The water is pumped continually into the one end of the tube, through which it passes with considerable velocity and then escapes as steam at the other end, through the nozzles direct to the turbine, without having entered any steam chamber or other large receptacle for steam whatever, which would only be a source of danger from explosion. The higher the steam pressure, the smaller is the specific volume of the steam, and consequently the diameter of the tube may be kept smaller without too much loss in pressure resulting from friction caused by the great velocity.

Now in case the tube should happen to burst, no matter even if to a considerable extent, the steam in the broken part would instantly rush out and as much steam would continue

to do so as could pass through an opening equal to two sections of the tube (one at each end of the fracture) until the boiler had emptied its contents. This quantity of steam is not greater, however, than can pass through the flues of the boiler and escape through the chimney without causing any damage whatever.

The danger of a fracture is, however, very remote indeed, as only solid drawn wrought iron tubes of very great strength are used, after having been submitted to a hydraulic pressure of more than double that of the working steam pressure. As an experiment, the boilers have been repeatedly allowed to explode and the result has always been the same, *i.e.*, the tube burst and the steam escaped through the chimney without causing the slightest damage.

As the steam and water capacity of the boiler has been reduced to the smallest dimensions possible, it follows as a matter of course that the boiler is exceedingly sensitive to every variation of load, therefore it has to be regulated automatically. By means of a special regulating apparatus the quantity of water and steam in the boiler is kept constant.

The air necessary for combustion is forced into the furnace by means of a fan, which is coupled direct to the driving shaft of the turbine. By means of an apparatus regulated by the steam pressure, and acting on the valves of the blast, the combustion is made dependent on the quantity of steam consumed. The natural draught is not practicable here as the fire has to be regulated according to the variations in the load. For this reason a powerful and easily regulated air blast must be employed. The layer of coals in the furnace is kept automatically at a constant thickness. The coal is fed in from the top, but the furnace only requires stoking every two or three hours. Owing to the use of an air blast, expensive smoke stacks, which are a necessary accompaniment to ordinary steam boilers, are altogether superfluous. The boiler is simply provided with a sheet iron pipe for carrying away the smoke and fumes into the open air. The construction of the boiler makes it quite unnecessary to build it in with brickwork.

The exceedingly powerful circulation of water in the boiler renders the heating surface very effective, which together with the fact that the space for steam and water is small, has made it possible to confine the dimensions of this new boiler within very narrow limits. For instance, a combination of a 100 H.P. turbo-dynamo having an output of 33,000 watts with a boiler of sufficient size, including the condenser, occupies a floor space of only 18½ by 11 feet.

CORRESPONDENCE.

The Telegraphists.

The Electrical Review is evidently extremely anxious to bring the Department in "not guilty," otherwise it is difficult to see how Mr. Walpole's letter convinces it that the telegraphists are wrong in their statement. Classification, of course, existed under the Fawcett scheme, but on every occasion upon which the abolition was asked, the officials replied that it was simply a check upon undeserving men, otherwise it was a benefit to the staff.

We are right in claiming that £190 per annum was the operators maximum, we are right in saying it has been reduced to £160—the Tweedmouth report stating the latter a sufficient sum. The senior class has had its duties altered from an operating to a supervising staff, and surely it must be evident that if you are to create all above the £160 scale into a superior class than operators, the operating maximum must be £160, Mr. Walpole states the proportion of superior appointments is the same as previously. Exactly, but he deducts the senior class from the general staff, and adds them to the superior list. Mr. Fawcett counted them amongst the general body, and this practice was continued until Mr. Walpole became secretary. Thus his statement is an evasion. With regard to technical acquirements, five out of a possible eight medals for the United Kingdom were won this year by students in connection with the C.T.O., and that school alone shows splendid returns, yet no amount of technical knowledge will carry a man beyond the £160 barrier, else why do 200 men now remain at the maximum—the majority being well skilled technical clerks.

Junior.

[But do not operators pass from the operating into the supervising section as readily now as they did heretofore, in other words are not the supervising duties such that in practice an operator of very moderate intelligence could readily perform them? The reason why 200 men remain now at their maximum is probably because there have been no vacancies to which they could have been promoted to fill. —Eds. Elec. Rev.]

Re Cost of Steam Power.

In your issue of the 3rd inst., under the above heading, you seem to express great surprise that the total cost for 1 H.P. per year, with compound condensing engines of 1,000 H.P. or so, should reach so low a figure as $11.64 or about 49s., and in some cases, with dearer coal, $14.85 or 61s. 6d. If we leave out fixed charges, the running expenses will be represented by $7.70 and $10.13, or 31s. 8d. and 42s.

We may affirm that in our manufacturing districts where cheap coal is available, the lowest of these figures are at least equalled and often beaten. The chairman of the Manchester Steam Users Association, speaking recently at an annual meeting, stated, that based on the coal returns made by the members of that association, which returns include "banking," the consumption of coal per I.H.P. per hour with two cylinder compound engines appears to be 2½ lbs. This, taking coal at 7s. per ton, equals ·094d. per H.P. hour and 3,070 hours × ·094d. = 24s. per H.P. per annum. Mr. Sheldon's lowest cost for fuel is 19s. 10d., the highest 27s. 6d. Whilst 2½ lbs. consumption represents the average practice of the members (which probably include various sizes of engines) 2 lbs. would be the figure often reached. This, of course, would bring the cost per annum to 19s. 2d.

During a discussion at a meeting of the Northern Society of Electrical Engineers, Mr. Nasmith, speaking about the economy of slow speed cotton mill engines, said there were plenty of compound engines working in Oldham to-day which, including all coal required for warming the mill, only gave a coal consumption of 1·75 to 1·8 lb. per I.H.P. per hour, the price of coal delivered being about 7s. per ton.

At our Peel Works, Adelphi, Salford, where there is a compound condensing engine by Hick, Hargreaves, capable of developing 600 H.P. at the speed it is at present running at, viz., about 50 R.P.M. (boiler pressure 100 lbs.) the figures for 400 H.P. for running expenses are for 2,650 working hours:—

	Per H.P. per annum. s.	d.
Coal	19	10
Labour	9	9
Oil, waste, packing, &c.	5	11
Repairs		6
Total	£1 16	0

The American figure for supplies seems very low, partly accounted for probably by the cheapness of American oil.

You will notice that this plant at our Peel works has not been running to its fullest capacity (which is 600 H.P.).

We are putting in an economiser, and expect to use the full 600 H.P. during this winter, when we have no doubt that we shall still improve on the above figures.

We hear that the cheapest water power in America is sold at about $15 per H.P. per annum. Lancashire can beat this.

The General Electric Company, Ltd.
G. Byng, *Managing Director.*

The Position of Motors for Electric Railroad Work.

I have read your article in last week's issue with some interest. I have not yet had an opportunity of reading the paper by Mr. William Baxter, jun., referred to by the writer of your article, but if Mr. Baxter is correctly reported, he would appear to have missed one or two very practical considerations which determine the position of motors; and Mr. Baxter's papers on traction work are so valuable generally, that it is surprising if his ideas on the present subject are

less clear than usual. We are approaching an era of heavy electrical railroad work, and the practice of such railways as the Liverpool Overhead or the common American Street Railway is apt to be misleading, if applied directly to such examples as the new underground railways in London, to which you refer at the opening of your article. Where we have a line running trains consisting of two cars, as at Liverpool, the provision of motors on the front bogie of one car, and the rear bogie of the other, either set being capable of doing the whole work, is a very rational arrangement; but when the first car is hauling, it is, for the purpose of logical classification, a "locomotive."

Where trains consist of several coaches, the advisability of using motor-cars is more doubtful; because, if one is to provide on the front cars sufficient motor power to haul the whole train, then, when we deal with lines where the trains run in alternate directions, we must usually provide a second set of motors on the rear car, which are out of use (except in emergencies) while the train is running forward, and only come into use when the train reverses, the other set then becoming spare. In other words, we have a double equipment, which means undesirable expense. If the rear motors are normally working to assist the front motors, we at once run into the danger which the Board of Trade regulation is framed to avoid, namely, that we are pushing part of the train weight. If this is done, and any obstacle retards the front carriage or tends to derail it, the rear carriages will "climb," and in tunnel railways especially we have here the elements of a dreadful disaster. When one comes to consider heavy railways like the Central London, where the trains will consist of seven coaches each weighing 15 tons, or the District, where the trains consist of nine coaches weighing about 14 tons each with live load, the maintenance of the service at the speeds required means an equipment of motors capable of exerting an aggregate horizontal effort measuring several tons. In such cases as these, large and heavy motor equipment is necessary; the trains are starting every two or three minutes throughout a long day, and if autocars were employed the number of motors required would be such that several coaches would have to be equipped. Then comes difficulties due to the switch gear and multiplication of connections required for running a large team of motors; the difficulty of making up trains; the difficulty of examining the motors during running, when they are scattered all over the train; and the difficulty of removing a defective motor-car from the metals, considering the enormously busy service. Besides all this, an electric locomotive rated at 300 to 400 horse-power, must obviously cost less for construction and maintenance than an equipment of motors agregating this power in from, say 8 to 12 machines. It appears to me that no one capable of apprehending the conditions can hesitate for a moment to admit that the employment of separate locomotives is the only practicable solution of such a problem.

It is interesting to note, by the way, that the engineers of the Waterloo and City Railway have arranged for four-coach trains, of which the first and last coaches carry motors. Some important practical experience will doubtless be obtained as to the exact amount of danger to be apprehended from partly hauling and partly pushing a train. It is to be hoped the experience will not be purchased too dearly.

Chas. E. Grove.

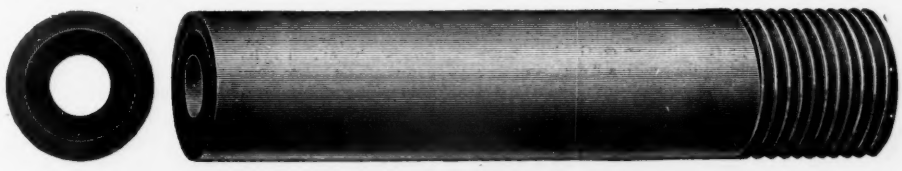
Thames Iron Works, *September* 14th.

INTERIOR CONDUIT WIRING DEVELOPMENTS.

In the Electrical Review for May 24th, 1895, we described at length the interior conduit wiring system then being introduced into this country by Mr. Frederick Bathurst, on behalf of the Interior Conduit and Insulation Company, of New York. The two years' experience gained on this side, and the friendly criticism with which the system has been met from time to time, have not been wasted, for various improvements and developments are now announced by the Conduit and Insulation Company, Limited, which has been carrying on operations in the manufacture of the system for some months. This company has works at Somer's Town, S.W., and offices at Ormond House, 63, Queen Victoria Street, E.C.; and in these days when the encouragement of home industry is so much advocated on every hand, the company may be pardoned for drawing attention to the fact that their conduits and fittings are now being made in this country.

Fig. 1.—Joint Box.

The company is now introducing a new steel conduit called "electric" pipe, inside which a more flexible material than formerly employed is used as an insulating material. This special piping is being made of the same thickness inside and outside as gas piping, as both the insulating lining and the steel armouring have been considerably reduced in thickness, and the company is consequently better able to compete side by side with gas piping. Therefore the same tools and standard sizes of pipe hooks, saddles, &c., used in gas fitting, can be employed. These alterations have been made, it is claimed, without in any way sacrificing efficiency. It has been found desirable to change away from the standard gas thread, and one has been adopted which is suited to the thinner steel armour and better fitted to electric requirements; the screw-thread used on these "electrical pipes" being based on that employed in connection with brass work, which is ligher in cut and contains more threads to the inch than that employed for iron. This lighter and longer thread has the effect of making the coupling sockets connecting the lengths together more watertight, and in the case of the larger sizes of conduit, reduces the labour of thread cutting so that one man can, with the ordinary tools, quickly and easily cut and thread all sizes of conduit required upon an installation. A special die plate to cut the



The Old Form of Tube.

The New Form of Tube.

lighter thread is made, and is adaptable for use in the standard die stock already possessed by those installing gas or water pipe systems. This improved steel armoured conduit is also understood to possess labour advantages over gas and water piping in respect to handling and bending.

It will be found that "twin conductor cable" (as now supplied by all the leading wire and cable manufacturers), is best suited for drawing into armoured conduits, and that a twin conductor of 5 amperes capacity (2 × 7/21) can be drawn into the ½ inch, and of 10 amperes capacity (2 × 7/18) into the ⅝ inch size conduit. Conduit wiring of this construction is equally applicable to any system of supply, continuous or alternating current, either at 100 or 200 volts pressure. Furthermore, the use of this twin conductor cable ensures the possibility of a good "centre of distribution" lay out, that will meet all the demands and conditions of electric wiring, with the employment of only two sizes of conduit (½ inch and ⅝ inch) and be suited to either surface or concealed work. It should be noted that three wires can be drawn into a certain sized conduit as effectually as two only, so that conduit construction lends itself admirably to the practice of running back a third wire for switching purposes, and that a 3-wire system of distribution can be installed as simply as the twin or lead and return system. Considerable work also has been successfully carried out in which a single insulated conductor is placed in the conduit and the outer steel armouring employed as the return conductor. Although awaiting the results of experience before advocating this construction for general use, it is apparent that such a method possesses "accessibility" and the other advantages peculiar to a conduit system, whilst providing at low first cost an "earthed-return concentric system."

All sizes of steel-armoured insulating conduit (½ inch—1½ inch) are supplied in 10-feet lengths, each end is reamed and threaded, and one coupling is furnished with each length. When a length has to be cut, it is preferable to use both pipe cutter and hack saw, and the end should be finally trimmed off clean and square by means of the "butt reamer." When installing it is preferable to employ "elbows," &c., as supplied from the factory, but the conduit, if handled carefully, can be "set" or "bent cold" by the wireman on the job. Sizes larger than 1½ inches diameter should be bent with a "dog," or other standard form of bending tool. The friction of "drawing in" wires is reduced to a minimum by a liberal use of soapstone powder, both in the tubes and on the wire. This lubricating medium can be best applied by filling an elbow with the powder and then blowing it into the tube. The wire can be covered by uncoiling it from a convenient box or barrel containing some of the powder.

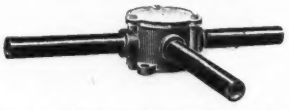


Fig. 2.—Fuse or Intersection Box.

Fig 3.—Switch.

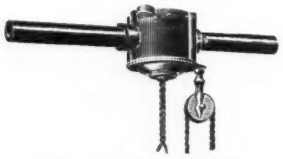


Fig. 4.—Ceiling Rose.

For his method of wiring, Mr. Bathurst claims the following advantages:—

Durability.—The insulating lining being a non-conductor of heat, prevents any temperature changes from promoting internal condensation within, and deterioration of, the steel pipe. It preserves also the insulated conductors contained within the pipe, under the least changeable conditions, and is, therefore, conducive to their greatly increased durability.

Safety.—The insulating lining provides a smooth cushioned interior surface, which will not abrade the insulating covering on the conductors, and resisting the effect of an internal "arc," prevents danger from fire risk due to any "short-circuiting" or "fusion" of the conducting wires. The lining proves more trustworthy than "fuses," and provides a "safety factor," which no method of testing can ensure.

Convenience.—The waterproof insulating lining being "steel armoured," cannot be damaged, and therefore guarantees a certain standard of insulation resistance under all accidents of material or workmanship. The insulating conduit method of wiring provides a system of electrical installation analagous to that of gas or water, and checkmates the ignorance or carelessness of unskilled workmen.

Accessibility.—The insulating lining gives a smooth, frictionless surface, over which conductors can be easily drawn, and thus makes possible any alteration or extension without fear of mutilating valuable decorations. A lined conduit can be guaranteed, free from the internal "fins" and "burrs" incident to plain pipe work, both before and after erection.

Economy.—Steel armoured insulating lined conduit provides absolute protection for the conductors, mechanical and electrical; immunity from fire risk; convenience for alteration and extension, and doubles the life, whilst greatly increasing the efficiency of the lighting system, with an increased cost of but 5 per cent. upon the total expenditure for complete installation.

In the company's list of accessories, the joint, intersection, and outlet boxes are particularly worthy of notice. The boxes are fitted with insulating linings. They are circular shaped, as shown in the illustration (fig. 1), and are indispensable in conduit wiring. They render almost impossible imperfect outlet connections, and the company has devised a standard method by remodelling the intersection box and designing a new set of porcelain fittings adapted for use as outlet connections. Boxes used for outlets are provided with an internal screwed stub, solid with the metal armouring (Bathurst's patent), so that the porcelain fittings, designed to suit all connections, can be quickly and effectively secured within the box by screwing them on to the stud. This construction avoids the drilling and tapping which hitherto has made possible the entrance of extraneous moisture, whilst the insulating lining prevents any internal condensation and the possibility of surface leakage trouble. In the case of earthed-outer systems, the internal stud serves a double purpose by forming a reliable contact terminal and the most convenient method of "earthing" the metallic armouring at the outlet point. In all standard boxes the connecting nozzles are now cast solid with the box and sent out ready drilled and tapped to suit the different sizes of conduits.

We illustrate in fig. 2 the application of this box as a fuse, in fig. 3 as a switch, and in fig. 4 as a ceiling rose. The boxes can also be used, with the necessary accessorial parts, as wall plugs, and to carry brackets or pendants.

THE ENGINEERS' STRIKE.

The close of last week was marked by a rumour that peace was in sight, on terms that would be acceptable to both sides.

Up to the time of writing this, we regret to say no confirmation of this rumour has reached us, and we hear that the Masters' Federation is gaining daily adherents. So far as we can see, the prospects of peace are very poor. The A.S.E. are obtaining help in small sums of £300 from outsiders, but the help so far reported is not a large item in the total expenditure. The levies must, however, provide several thousand pounds per week, and every adherent to the Federation reduces the number to be levied upon, and increases the number of the idle. Unfortunately for the Federation there are large numbers of small firms who are being cruelly squeezed by the A.S.E., and yet who cannot afford to close up their works. Yet these small firms are usually paying good wages, and it is from large numbers of small firms that the A.S.E. are really drawing their funds and prolonging the strike. It is unfortunate for the Federation that these small and weak firms cannot be assisted to withstand the stress, and have to be left at the mercy of the A.S.E., for they are really supplying the sinews of war to the strikers and cannot help themselves. Since the foregoing was written, it is reported that Mr. Siemens, the chairman of the London Federation, has stated there is as yet no compromise in view. He also states that the Federation is getting stronger.

The *Mining Journal*, in commenting upon the situation last week, thought it hopeless to attempt to reason with the men, who, as one party to the dispute, start off with an axiomatic definition of foreign competition as a bogey. Neither European nor American competition is a bogey. The hard conditions of life on both the Continents, and the long hours, combined with the effects of protective tariffs, are making competition felt. When Americans put rails into Ireland at less price than our own mills, of what use is it to say that these rails were not rolled for the money. They are sold for the money, and this fact is in itself a fact of competition. The selling price of a rail is made up of materials, fuel, labour and management, and if a larger output is made, this latter item is spread over a larger tonnage, while there is also a great temptation to run a business at a big output and a small apparent loss, in order to keep the staff together. When American rails are sold over here at a loss, the man who pays that loss is probably the rail buyer in America, and the English, as a nation, get the benefit; but these things are not unmixed blessings, and the very diversion of trade into new channels is apt to continue. English workmen seem to think that if they drive trade out of England, they will be able to follow it abroad and get employment. What egregious folly is this to strike for an eight hours' day, and failing to get it, to follow the work abroad and work 12 hours for less money, under worse conditions of life and dearer food. Really the English workmen are letting themselves be strangely led by the vapourings of ill-informed and inexperienced leaders.

We are unfeignedly sorry for the older men of the A.S.E., and would draw attention to the issue of *Fairplay* of September 2nd last, in which there is given a review of the finances of the Society for the past 23 years. It is pitiable reading. In 1874, the total calls upon members were £2 12s. In 1896, they had steadily grown to £4 13s. 7d. Yet in the former year there were only some 43,000 members, against fully 87,000 in the latter year. The total funds accumulated in the same two years were, respectively, £275,146 and £305,521; a paltry £30,000 of an increase for over double membership. Per head, the accumulated funds work out at £6 3s. 5d. and £2 18s. 3½d. Relief claims have been going up in the time. The superannuitants have increased from 449 to 2,774, and to meet this

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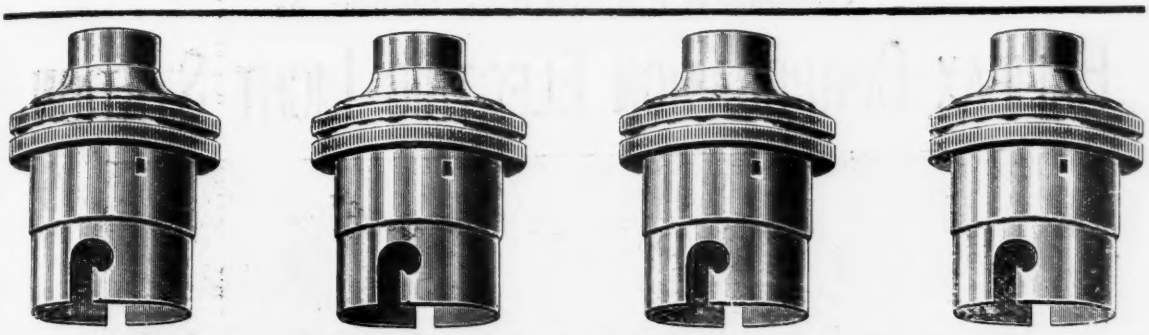

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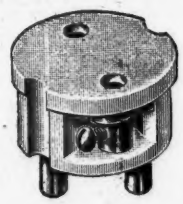

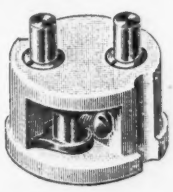

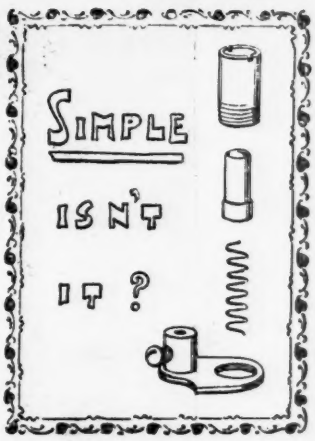

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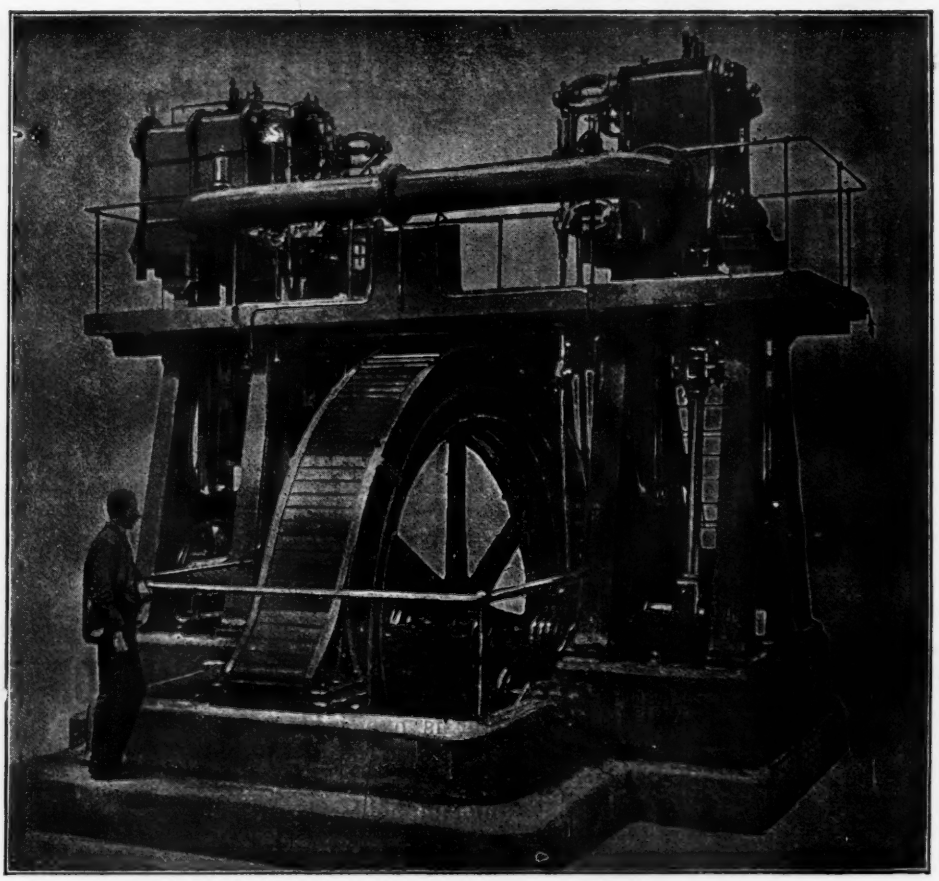

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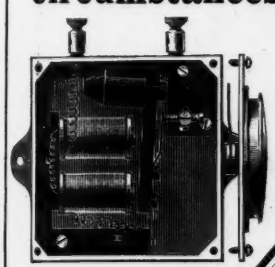

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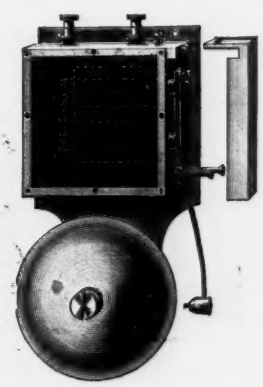

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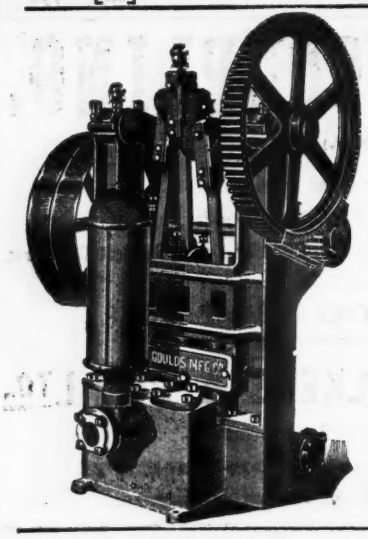

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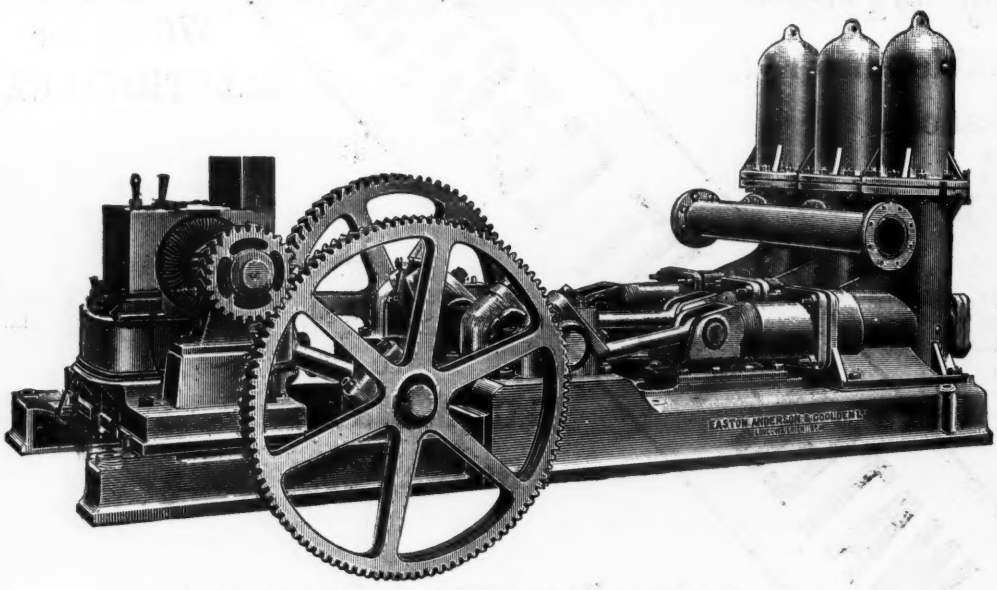

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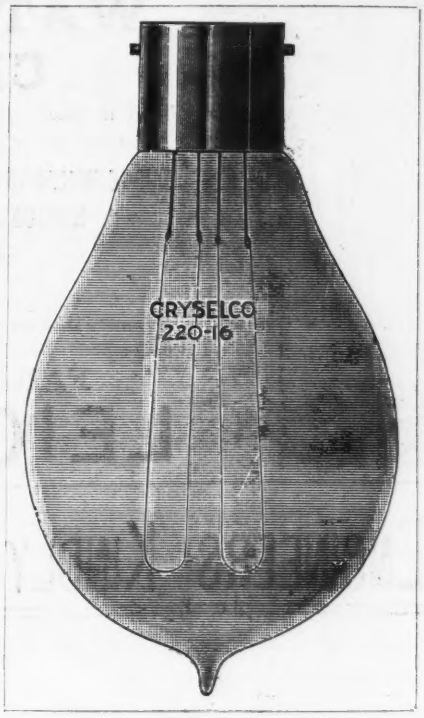

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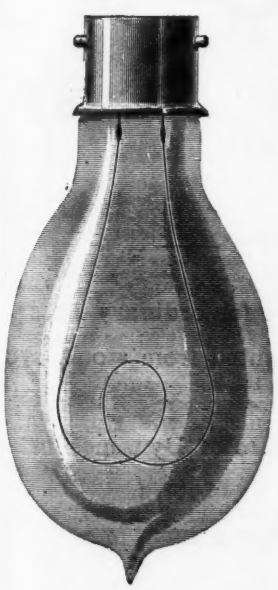

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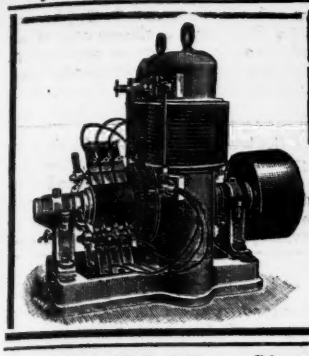

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PREMIUM PUPIL.—Electric light engineer and electrical instrument maker, holding appointment as lecturer in electric technology at a technical school near London, has vacancy for a Pupil, resident or non-resident. Private laboratory. References given and required. — Apply 1,525, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1525

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HARBURG INDIA-RUBBER C. COMPANY.

London Warehouse: F. WINTER, 138, London Wall, Wood St., E.C.

EBONITE.

1119

PREMIUM PUPILS.—Large electrical manufacturing works, near London, have several vacancies.—Address 1,278, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1278

SKILLED Transformer Hands Wanted, North of England.—Write, stating age, experience, and wages required, to 1,595, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1595

TRAVELLER Wanted for Glasgow, to represent electric light accessories manufacturers Experience and good connection indispensable.—State previous experience and terms, 1,555, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1555

TRAVELLERS Wanted for London and Midland Counties to push sale of British made incandescent lamps. Experience and good connection indispensable.—Write, stating terms, &c., 1,597, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1597

VACANCY. — Assistant engineer in generating station. Opportunity for a man having mechanical training to gain electrical experience.—Apply, stating experience, age, &c., to ALTRINCHAM ELECTRIC SUPPLY CO, LTD., Broadheath, nr. Manchester. 1571

WANTED, by a leading firm of electrical engineers, Assistant Draughtsman. — Apply, stating age, experience, and salary required, to 1,575, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1575

WANTED in an Electrical Manufacturing Company near London, a capable man to act as store keeper, time keeper, and to take charge of the packing department. Preference given to one who has a knowledge of prime costing, and who can write shorthand. Good wages to a thoroughly competent man.—Apply by letter, stating experience, wages required, and giving copies of testimonials, to 1,588, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1588

WANTED, by a leading firm of manufacturers of electric fittings and accessories, a Traveller for London and district. Liberal salary and commission to a first-class man. Applications treated in confidence.—Apply 1,505, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1505

WANTED, for a London Electric Lighting Company's office, a Clerk capable of keeping books and having some technical knowledge, age about 21.—Reply by letter, stating salary required, previous experience, references, &c., to "ELECTRIC," care of Streets, 30, Cornhill, E.C. 1584

WANTED, in Leeds, a competent young Assistant Electrician, desiring, with moderate pay, one or two years' practical experience, without unpleasant surroundings, of electric light wiring and fitting; also another with a taste for telephone and bell work, and willing to devote himself to this, with occasional experience of lighting.—Apply by letter, giving particulars, to 1,576, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1576

WANTED for abroad, smart Electrician and Wireman, used to electrical repairs to arc lamps, dynamos, and fittings, must be a good mechanic and of steady habits. Wages £3 10s. per week. — Address "No. 218," at Horncastle's, Cheapside, London. 1608

WANTED, by the Wireless Telegraph and Signal Company, Limited, competent Assistants well up in electrical science and accustomed to Hertzian work and practical telegraphy.—Apply in the first instance by letter only, to 82, Mark Lane, E.C, stating age, qualifications, and salary expected. 1606

SITUATIONS WANTED.

Where Advertisements are to be answered to a given number, letter, or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

AS Engine Driver, Stoker, or in charge of hydraulic machinery; many years' experience.—References permitted to Editors REVIEW. 1,396, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1396

[Continued on next page.]

A.I.E.E., late manager and partner in electrical engineering firms, seeks engagement, eight years' experience in dynamo design and construction, estimating, and installation work, control of men, and business experience.—1,522, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1522

A YOUNG Electrical Engineer (24) well educated, desires post as Assistant in contracting or consulting electrical engineer's office, capable of superintending installation work, estimating, &c. Central station experience; five years' experience with leading firms, home and abroad. Highest testimonials.—1,515, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1515

ACCUMULATORS.—A.I.E.E., with thorough knowledge of the manufacture and management of Accumulators, and with good business connection, seeks re-engagement; highest references.—Apply, 1,591, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1591

AS CLERK or STOREKEEPER, six years' experience with manufacturers, knowledge of installation work, good references.—1,604, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1604

COMPETENT WIREMAN, three years foreman, seeks situation to take charge of installation and general electric work.—1,605, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1605

ELECTRICAL ENGINEER (20), four years' practical general experience, seeks engagement as junior Assistant.—1,581, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1581

ELECTRICAL ENGINEER (24) desires Engagement. Two years' experience in large shipping company as sea-going electrician-in-charge.—Address, 1,586, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1586

ELECTRICAL ENGINEER (age 26), accustomed to management and carrying out of lighting and bell installation work, desires Appointment. Excellent references and testimonials; moderate salary.—Address, 1,569, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1569

ELECTRICAL ENGINEER (32), eight years' workshop and drawing office experience, over four years' estimating, designing and installation work, desires Position, home or abroad. Speaks German; good references.—"E. C. E.," 31, Oxford Road, Putney, S.W. 1598

ELECTRICIAN, 10 years' shop, drawing office, and installation experience; also charge of plant. Good references.—1,590, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1590

ENGINEER requires situation at electric supply company, to take charge of engines, boilers, and their repairs; nine years' experience with high speed electric engines; good references.—"H. G. G.," 29, Victoria Road, Harborne, Birmingham. 1520

ELECTRICAL ENGINEER (24) seeks engagement, traction preferred, three years City Guilds Institute, two years manufacturing firm, charge of high tension plant.—Apply 1,504, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1504

HOME OR ABROAD.—Electrical Engineer seeks re-engagement; good and varied experience in installation work, manufacturing, estimating, and control of men.—"B. W.," Willing's, 162, Piccadilly, London. 1611

LABORATORY ASSISTANT (34), Electrical Mechanician. Good Draughtsman, skilled in installation management.—1,594, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1594

M.I.E.E. (31) desires an Engagement of a commercial technical character in England, the Colonies, or abroad. British and U.S. experience, chiefly with battery firms.—"H. B.," 14, Narcissus Road, N.W. 1592

TO CONSULTING ENGINEERS.—A.I.E.E., with wide practical experience, seeks engagement as assistant in office; highest references.—Apply, 1,592, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1592

TRAVELLER, 10 years' experience all kinds electric fittings and accessories, open for engagement, October. Sound connection, North England.—Address, "ELECTRICAL TRAVELLER," W. E. Eaton, 10, Richmond Hill, Old Trafford, Manchester. 1602

YOUNG GIRL wishes Employment, thoroughly understanding Electric Bell, Portable, and Bobbin Winding.—1,607, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1607

YOUNG Electrical Engineer, thorough practical and theoretical training, good draughtsman and designer, speaks French and German, desires situation.—Address 1,533, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1533

ARTICLES FOR SALE AND WANTED, PARTNERSHIPS, &c.

Where Advertisements are to be answered to a given number, letter or *nom de plume* at the ELECTRICAL REVIEW Office, applications for names and addresses of the Advertisers will be entirely disregarded.

ACCUMULATORS (old), Copper Cable, Scrap Metal, Metal Dust, and Metal Refuse of any kind bought for cash.—Write A. BROWN, 77, Lansdown Road, Dalston, London. 1589

ACCUMULATOR RECHARGING.—Peto & Radford, Ltd., having increased their storage battery plant, are now prepared to make additional contracts for recharging accumulators of all sizes. Power available night and day. Telephone No. 6,994.—PETO & RADFORD, LTD., 57B, Hatton Garden, London, E.C. 1488

ACCUMULATOR Charging.—C. H. Cathcart & Co., having plant specially adapted for this purpose, charge cells of all sizes promptly, thoroughly, and cheaply. Terms on application. Accumulators on hire for temporary lighting, experimental uses, &c.—3, Dorset Buildings, Salisbury Square, Fleet Street, E.C. (Telephone No. 65,266). 7345

AN Electrical Engineer and Contractor in Belfast, having an extensive showroom on ground floor with large window in a principal street, and having a connection throughout Ireland with over 60 electric light installations of a total of over 25,000 lamps, is desirous of representing a first-class manufacturing firm.—Apply to 1,570, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1570

FOR SALE.—

Marshall's MP class vertical engine, cylinder 13" dia., 16" stroke, 120 revs. per minute, giving 56 effective horse-power.

Multitubular boiler, by Tinkers, Ltd., Hyde, height 13 feet, dia. 5 ft. 6 inches, number of tubes 112, now working at 120 lbs. steam pressure, complete with all mountings; also vertical feed-water heater.

Donkey pump, by Mumford, with ram 2½" dia., 4" stroke.

The above may be seen at the Empire Theatre, Birmingham.—Apply THE PRESTON ELECTRIC CO., LTD., Birmingham. 1510

INVESTMENT.—An old established and large electrical supply house contemplate opening branches shortly in Birmingham, Manchester, Newcastle, and Glasgow, is desirous of negotiating with gentlemen thoroughly acquainted with the electrical trade to take charge of such branches with a view to partnership.—Capital required. Letters, with fullest particulars, to 1,579, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1579

LESSONS BY CORRESPONDENCE in Electric Light and Power Engineering, based on City and Guild's requirements. Preliminary Course, 12 lessons, 6s. 6d. Ordinary Grade, "Course A," 15 lessons 10s. Honours Grade (Central Station Working and Transmission of Power Installations), Course B, 20 lessons 25s. For syllabus and full particulars, apply, "ENGINEER," 83, St. Dunstan's Road, Hammersmith, London, W. 1583

PARTNER Wanted with about £500 to extend electrical manufacturing business in London, one with practical knowledge and small business connection preferred.—1,512, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1512

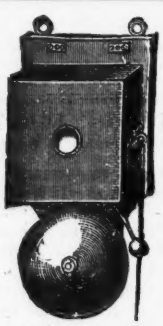
PLATINUM in any form and quantity, purchased at highest prices by DERBY & Co., 44, Clerkenwell Road, London. 6922

WANTED.—Second-hand Motors, one shunt-wound and one series, each about 5 H.P., and 100 volts.—Give particulars as to price, speed, &c., 1,600, ELECTRICAL REVIEW, 4, Ludgate Hill, London. 1600

WANTED, a Partner to take over an Electrical Engineering Business requiring further capital, now being carried on by a Limited Company.—Apply, GARDNER & BEANLAND, Accountants and Auditors, 35, Hustlergate, Bradford, Yorkshire. 1506

WANTED, Electric Lamp Tops and Scrap Platinum.—EDEY AND CO., 29, Ludgate Hill, London. 1473

ELECTRIC Bells, Pushes, Lamps, Wires,



Telephones, Batteries, Switches, Electro-Medical Apparatus.

Price List of Electrical Accessories on application.
LIBERAL DISCOUNTS TO THE TRADE.

S. HARRISON, Manufacturing Electrician,
Office—697, ORMSKIRK ROAD, PEMBERTON, WIGAN.
Works—ELLESMERE MILL, NEWTOWN, WIGAN.
Registered Telegraphic Address:—"HARRISON, PEMBERTON." 1107

ENGELBERT & Co., London,
LUBRICANT MANUFACTURERS,
Vide full advertisement in last issue, also next issue.

THE PHŒNIX DYNAMO MANUFACTURING CO.,
Makers of all kinds of Electrical Plant, Hubert Street Works, Leeds Road, Bradford
See our Page Advertisement First Friday in each month.

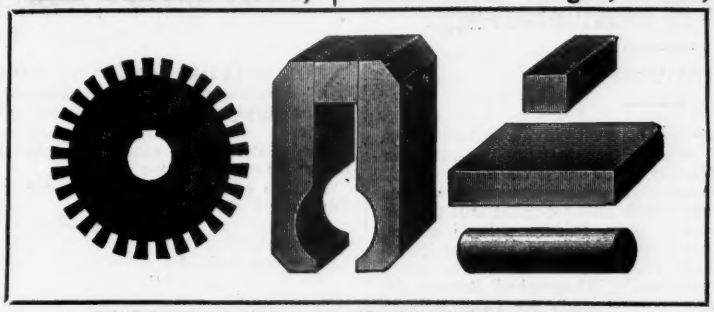
Now Ready, No. 12 of
THE AUTOMOTOR AND HORSELESS VEHICLE JOURNAL.
MONTHLY, ILLUSTRATED. PRICE 6D., POST FREE, 7D.; YEARLY, 7S.
No. 12 contains French Heavy Vehicle Trials—The Daimler Company—the Electric Cabs—the Month's Motor News, Inventions, Law Reports, &c., &c.
At W. H. Smith & Sons' Bookstalls, usual Newsagents, or direct from 1393
F. KING & CO., Ltd., 62, St. Martin's Lane, LONDON, W.C.

TO MANUFACTURERS OF DYNAMOS, MOTORS, TRANSFORMERS, &c.

STAMPINGS OF ALL DESCRIPTIONS, | **MAGNETS—Forged, Rolled, Cast or Stamped, Finished, or in the Rough.**

DISCS up to 60 inches diam.
SLOTTED WORK a specialty.

Accuracy of Stamping and Highest Electrical Results Guaranteed.



SLABS & BARS in Suitable Sections for Magnets, Cold Sawn to lengths.

ROLLED AND FORGED SHAFTING, EYE BOLTS MICA, COMMUTATOR SEGMENTS, &c. 1245

ROBERT JENKINS, 88, BISHOPSGATE ST. WITHIN, LONDON, E.C.
Telegraphic Address:—"Permeable, London."

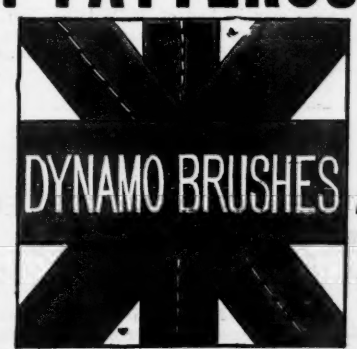
WE ARE NOW SUPPLYING A
SMALL
GAS ENGINE & DYNAMO COMPLETE,
Capable of Lighting CONTINUOUSLY
THREE 8-VOLT LAMPS,
OR CHARGING
FOUR 6-VOLT ACCUMULATORS,
AT
£10 10s., subject.

SEND FOR LIST.

H. M. SALMONY & CO.,
MANUFACTURING ELECTRICIANS,
118-120, Charing Cross Road, London, W.C.
Telephone, 5,479, GERRARD. Telegrams:—"SALMONY, LONDON."

W. PATTERSON.
COPPER — GAUZE

The most Efficient Brush made.



PRICES ON APPLICATION.

Telegrams: "Wirework, Newcastle-on-Tyne."

THE CITY WIRE WORKS,
NEWCASTLE-ON-TYNE. 6294

THE WALTHAM
ENGINEERING CO.
Art Metal Workers.
SEND FOR NEW
CATALOGUE
OF FITTINGS FOR ELECTRIC LIGHT
IN FRENCH AND ENGLISH STYLES).
ORNAMENTAL SWITCH COVERS, &c.

98, YORK STREET, WESTMINSTER, S.W.
(Next St. James's Park Station). 6262

Official Notices.

CITY AND COUNTY OF KINGSTON-UPON-HULL.

ELECTRIC TRAMWAYS.

THE CORPORATION of the above City invite tenders for the electrical equipment of their tramways, to the extent of about nine miles double track and ½ mile single track.

It will be open to contractors to submit tenders for various systems, and the contract, which will not be divided, will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding and all accessories, also the first instalment of cars (15 motor cars and 5 trailers).

It is expected that the specification, lithographed plans of the routes and other particulars will be ready for issue early in September, and copies, when ready, may be obtained from the City Engineer, Hull, by persons proposing to tender, upon payment of a deposit of £10, which will be refunded upon receipt of a *bona fide* tender and return of the papers and plans supplied.

Cheques to be made payable to Mr. THOS. G. MILNER, City Treasurer.

Tenders endorsed "Tender for Tramway equipment" are to be addressed to the Chairman of the Works Committee, and delivered at the Town Clerk's Office, Hull, before noon on Friday, November 5th, 1897.

The Corporation do not bind themselves to accept the lowest or any tender.

By order,
A. E. WHITE, *City Engineer*,
A. S. BARNARD, *City Electrical Engineer*.

Town Hall, Hull,
August 26th, 1897. 1482

BOROUGH OF PLYMOUTH.

THE PLYMOUTH CORPORATION is prepared to receive Tenders for the undermentioned Engineering Works, in connection with the Tramways of the Borough, viz.:—

Contract No. 10.—Overhead Trolley Line, Posts, Brackets, &c.

Contract No. 11.—Tramcars, Trucks, Motors, Trolley Arms, &c.

Contractors may tender for either of the Contracts, but not for a part of any Contract.

Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained from the undersigned on the deposit of Two Guineas for each copy, which will be returned on receipt of a *bonâ fide* tender upon the prescribed form, and within the stated time.

Should a contractor withdraw his tender, the amount of his deposit will be forfeited.

A copy of the drawing of posts will be sent to those wishing to tender for Contract No. 10.

Sealed tenders, endorsed "Engineering Contract No.....," must be delivered to J. H. ELLIS, Esq., Town Clerk, Plymouth, not later than the 2nd day of October, 1897.

The Corporation does not bind itself to accept the lowest or any tender.

The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

JOHN H. RIDER,
Borough Electrical Engineer.

East Street, Plymouth.
September 6th, 1897. 1389

MUNICIPALITY OF IPSWICH, (QUEENSLAND).

ELECTRIC LIGHTING.

THE COUNCIL OF THE MUNICIPALITY OF IPSWICH (Queensland) are prepared to receive Tenders for the Supply and Erection of the following plant:—

Section A.—Tubular boilers.

Section B.—Feed, Steam, and Exhaust Pipes, Pumps and Heaters.

Section C.—Steam Alternators and Exciters.

Section D.—Switchboard.

Section E.—High and Low Tension Mains, Junction Boxes, &c.

Section F.—Transformers.

Specifications for the above, with general conditions of the contract, may be obtained on application to the undersigned, or at the offices of Messrs. GORDON & GOTCH, St. Bride Street, Ludgate Circus, London, E.C.

The Council reserve the right to accept the tender of any contractor for any one or more of the Sections, and they do not bind themselves to accept the lowest or any tender. Tenders, marked "Electric Lighting, must be delivered to the undersigned at the Council Chambers, Ipswich, Queensland, not later than noon on MONDAY, NOVEMBER 15th, 1897.

ALBION HAYNE,
Town Clerk. 1544

Official Notices.

BRAY TOWNSHIP.

NOTICE IS HEREBY GIVEN that the Bray Township Commissioners will be prepared to receive and consider Tenders for the supply of 15 Alternating Current Arc Lamps, Globes and Carriers.

Specification, and any other information required, will be forwarded on application

Tenders will be received not later than 10 a.m. on MONDAY, SEPTEMBER 27th.

By Order,
P. MACDONNELL,
Town Clerk.

Town Hall,
Bray. Ireland,
September 9th, 1897. 1572

ELECTRIC LIGHTING FOR TOWN OF BELIZE, BRITISH HONDURAS.

THE DISTRICT BOARD OF BELIZE, the capital of British Honduras, invite tenders for the lighting by electricity of the town of Belize.

The system decided upon is that known as the 3-wire or neutral wire system, and comprises boilers, engines, dynamos, accumulators, copper mains, flexible leads, iron lamp standards, switches, fuses, lamps glow and lamps arc, meters, &c., &c.

Full particulars of the requirements of the Board can be obtained on application to Mr. A. R. M. Simkins, M.I.E.E, care of F. Otto, Esq, Tower Chambers, Moorgate Street, London, E.C., (telegraphic address, "Helios, London). Tenders should be addressed to, and should reach Mr. Simkins not later than OCTOBER 20th, 1897, and should be enclosed in a sealed package, marked "Tender for Electric Lighting."

The Board does not bind itself to accept the lowest or any tender.

E. B. SWEET-ESCOTT,
Colonial Secretary, British Honduras,
and Chairman of Belize District Board

August 26th, 1897. 1600

Sale.

In the High Court of Justice, Chancery Division.
Mr. Justice Romer.

THE GENERAL ELECTRIC POWER AND TRACTION CO., LTD. (In Liquidation) v. LEWIS.

Messrs.
PERCY HUDDLESTON & CO.

Have received instructions to offer for

SALE BY AUCTION,

at the Mart, Tokenhouse Yard at an early date (unless disposed of by Private Contract) the valuable leasehold premises known as the

COPPER DEPOSITING WORKS,
WEST FERRY ROAD, MILLWALL, LONDON, E.

having a ground area of about 75,000 feet and having a frontage to the River Thames of 91 feet. The wharf is connected with the various buildings with tramways, and is held at a ground rent of £250 per annum.

The buildings comprise Engine and Boiler Houses, Depositing House, Wire Mill, and other buildings, also Manager's House, Offices, &c. The whole of the fixed plant and machinery will be included in the purchase and include two pair of new Horizontal Compound Condensing Engines, and three High Pressure Boilers, by Davey, Paxman & Co., Dynamos, Vats, Pumping Plant, Cranes, &c.

Further particulars may be had of E. Wilding, Esq., Chartered Accountant, 2, Clement's Inn, W.C.; Messrs. Ward, Perks, & McKay, Solicitors, 85, Gracechurch Street, E.C., and of the Auctioneers, 72, Finsbury Pavement, London, E.C. 1596

Educational Notices.

CITY OF LONDON COLLEGE,
WHITE STREET, MOORFIELDS, E.C.

Michaelmas Term Commences September 27th.

CLASSES are held in Magnetism and Electricity, Sound, Heat, Light, Mathematics, Chemistry and other Science subjects; Laboratories for practical work. Preparation for London University and other Examinations.

Prospectus gratis on application to

DAVID SAVAGE,
Secretary. 1388

Educational Notices.

VICTORIA UNIVERSITY,
UNIVERSITY COLLEGE, LIVERPOOL.

DEPARTMENT OF ENGINEERING.

SESSION 1897-8 COMMENCES OCTOBER 4TH

COMPLETE Courses of Instruction are arranged in:—

(1). Civil Engineering.
(2). Mechanical Engineering.
(3). Electrical Engineering.

These courses enable students to qualify for University Degrees, and for the College Certificates in Engineering. They comprise in addition to special Engineering Lectures and Laboratory Work, instruction in Mathematics, Physics, Electrotechnics, and Chemistry.

The Engineering Laboratories and also the Electrotechnical Laboratories are completely equipped with modern appliances.

The College Prospectus, and also the Special Engineering Prospectus can be obtained on application to the Registrar. 1547

THE SOUTH-WEST LONDON POLYTECHNIC INSTITUTE

MANRESA ROAD, CHELSEA, S.W.

Principal - Prof. HERBERT TOMLINSON, B.A., F.R.S.

Session 1897-8 Commences September 28th.

DAY TECHNICAL COLLEGE.—Complete Courses of Instruction, extending over Two Years, are arranged in:—

1. Electrical Engineering.
2. Mechanical Engineering.
3. Chemical Industries.

Fee for the Complete Course, £15 per annum. Occasional students can take up any part of a Complete Course.

EVENING CLASSES IN ELECTRICAL ENGINEERING.—Special Advanced and Elementary Courses of 30 Lectures each will be given in this subject, followed by practical work in Electrical Testing, Dynamos and Motor Trials, Gas and Steam Engine Trials, Alternating Current Work, Specifying and Estimating.

Advanced Class, Mondays 7.30-10 15. Fee, 10s. per Session.
Elementary Class, Thursdays, 7.30 10.15. Fee, 10s. per Session.

ELECTRIC WIRING AND FITTING.

Advanced and Elementary Classes, Tuesdays, 7.30-10. Fee, 10s. per Session.
Instrument Making, Wednesdays, 7-10. Fee, 10s. per Session.

For further particulars apply to the SECRETARY. Prospectus, Price 1d., by Post 2½d. 1599

Educational Notices.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR.

ELECTRICAL ENGINEERING.

PROF. ANDREW GRAY, LL.D., F.R.S., will begin in October next a systematic COURSE OF INSTRUCTION in Electrical Measurement and Practical Electricity. The Physical Laboratory is fully equipped with a Compound Steam Engine, Dynamos, Transformer, Secondary Battery, and the most approved modern Measuring Instruments for all branches of Electrical Engineering.

Laboratory Fees at the rate of £1 1s. per Term for six hours per week. Composition Fee for all College Lectures for the Session, £10

Applications for Calendar, Prospectus, and general information to be made to

J. E. LLOYD, M.A.,
Secretary and Registrar.

1811

DOULTON & Co.

Manufacturers of

INSULATORS.

BATTERY JARS,

POROUS CELLS,

AND ALL KINDS OF

POTTERY FOR ELECTRICAL PURPOSES.

LAMBETH, LONDON, S.E. 4795

PAUL

MANUFACTURERS OF
Electrical and Physical Instruments.
44, HATTON GARDEN, E.C.
Catalogues Free. 8285

STERLING MERIT - IS THE - KEYNOTE - OF - SUCCESS.

This explains why the . . . .

No. 4 YŌST TYPEWRITER

has so easily attained a world-wide fame. Being constructed of the finest materials, speedy, light, compact, and economical in working, and having an Ink Pad which is guaranteed for six months, it is indeed

ADOPTED BY ROYALTY AND ARISTOCRACY AND MORE THAN **35,000** OTHER USERS.

The ideal Writing Machine.

Full Particulars on Application to

THE YŌST TYPEWRITER CO., Ltd.,

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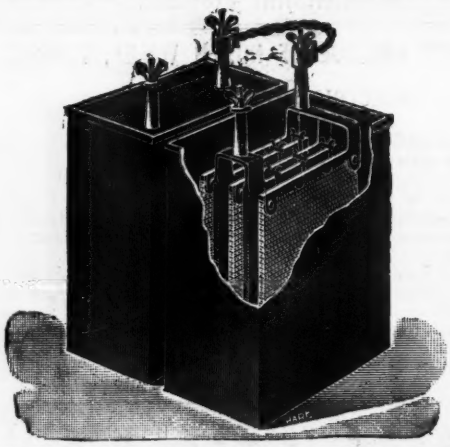
LIVERPOOL: 22a, North John Street.
GLASGOW: 112, St. Vincent Street.
MANCHESTER: 3, Deansgate.
BIRMINGHAM: 73, Temple Row.
DUBLIN: 17, Nassau Street.
LEEDS: 15, Briggate.
CARDIFF: 77, St. Mary Street.
NEWCASTLE-ON-TYNE: 50, Dean Street.
BELFAST: 13, Rosemary Street.
MARSEILLES: 25, Rue Paradis.
PARIS: 36, Boulevard des Italiens.
LYONS: 2, Rue Lafont.
EDINBURGH: 12, North St Andrew Street.



CARRIAGE TYPE "C" 5.—Total weight, 23 lbs.; Capacity 80 ampere hours at a discharge rate of 20 amperes. Overall Dimensions, 7-in. × 4-in. × 13-in. 100 ampere hours at half rate discharge.

THE LAMINA ACCUMULATOR

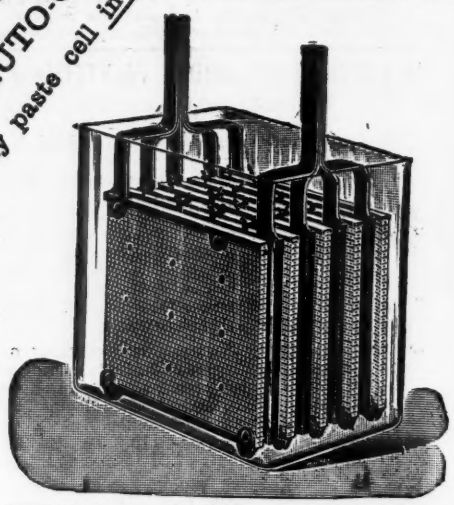
The Only Suitable Cell for AUTO-CARS.

Plantè Principle, YET lighter than any paste cell in existence

Write for New List and Full Particulars to the

ELIESON LAMINA ACCUMULATOR COMPANY, LIMITED,

4, Greenland Place, CAMDEN TOWN, N.W.



LIGHTING TYPE "A" 9.—Total weight, 71 lbs.; Capacity, 320 ampere hours at a discharge rate of 40 amperes. Overall Dimensions, 8-in. × 10½ in. × 12-in. 420 ampere hours at half rate discharge 1188]

HOW TO BUILD DYNAMO-ELECTRIC MACHINERY,

Embracing Theory, Designing and the Construction of Dynamos and Motors.

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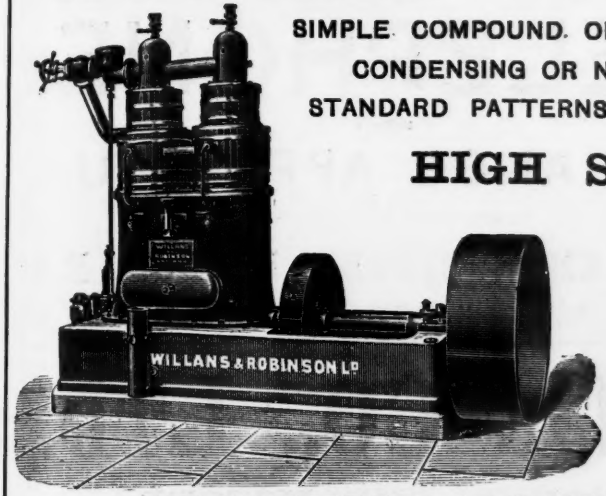

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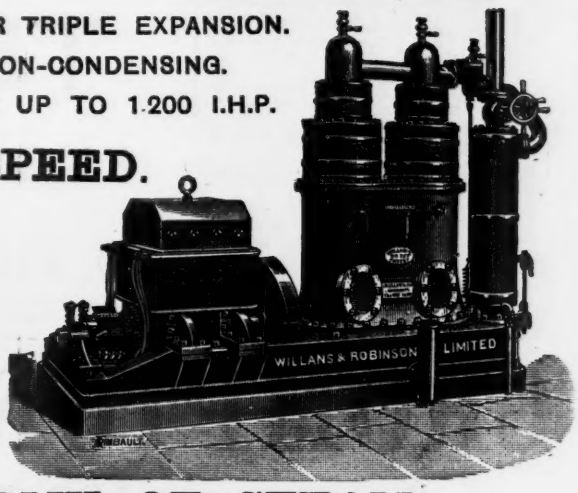

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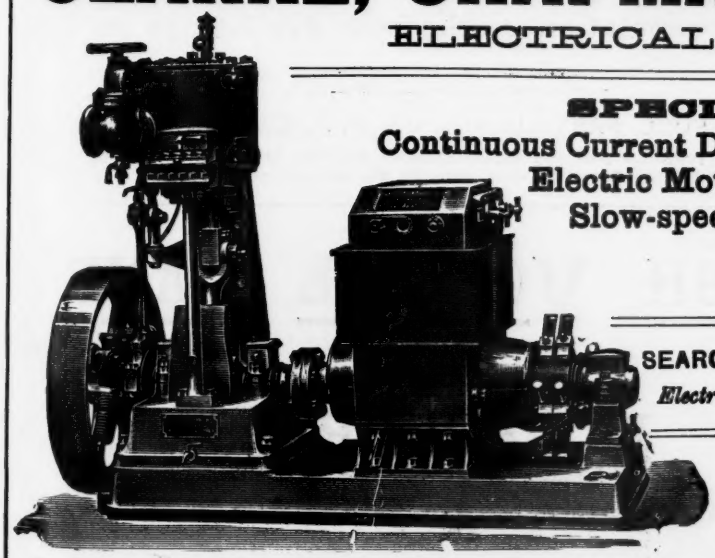

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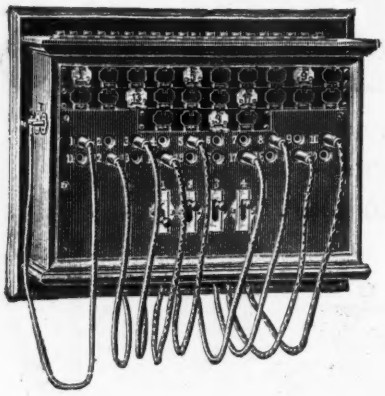

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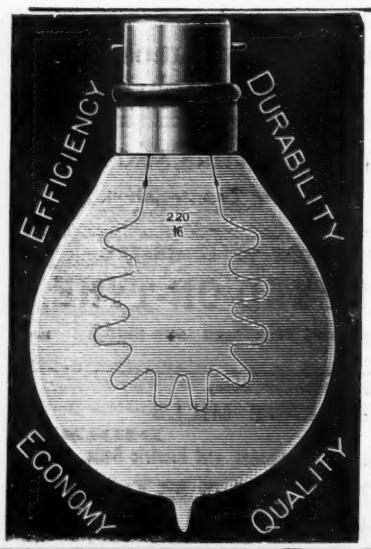

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the age of superannuation has been twice raised, and now stands at 55 years, while the payments of 7s. to 10s. per week are not what the older members entered for, and for what they have been paying all these long years. Sick payment in the same time has more than doubled in amount for nearly three times the number of claimants. Funeral expenses have about doubled. The total income has *nearly* trebled since 1874. The total expenditure has more than trebled. The expenditure per head has gone up from £1 17s. 3½d. to £2 16s. 9½d. *Fairplay* estimates that during the 45 years life of the society, nearly half its expenditure has been upon strikes. It has spent its provision for sickness, accident, and old age, and, of its present fund, Jno. Burns says it will spend every penny, leaving the sick and the aged to depend, in future, entirely upon the weekly contributions of members in work. Is it likely that the younger members who have howled for the strike will continue paying up in the future? We think it extremely doubtful. A man who has paid for four or five years thinks he has done well to have drawn, perhaps, nearly all his payments back in this one strike, if it lasts a few weeks longer. But what of the old men who have paid their 25 years, and are now paying 4s. 1d. weekly, and expecting to be soon in receipt of superannuation pay? We have one before us now. He would leave the society, were it not he has been paying for so many years. He is a good workman and has a large family, and we much fear he will pay away in levies this year more than he will ever draw for superannuation. Probably he has paid out about £100. How much better he would have done to have gone into a reputable insurance office! When the funds have been depleted, it will be obvious to the younger men that they cannot hope for much benefit themselves when old. They will see the old men done out of their superannuation, and will reason out that they may as well save their money now, or spend it, rather than (when they are themselves old) see their accumulated funds going to make a young men's holiday, for this miserable strike is nothing else. It is a brutal and cowardly holiday, seized by a lot of young men at the bidding of young officials to the robbery and spoliation of the aged, the provident, the infirm, and the sick.

In Sheffield we learn that Messrs. Craven Bros. are members of the Federation, and their men have struck work to the number of over 100. At Jno. Brown & Co. it is reported very little difficulty is being experienced, but a good deal of picketing is going on. At Sir W. Gray & Co.'s shipyard at West Hartlepool, it is decided to close down on the 21st inst., and the outlook is gloomy. It is impossible to look upon all this trouble without being convinced that the strike is a wicked piece of work. Lest our statement be thought too strong, we give a few figures of the wages paid by a firm in London:, engineers 45s., smiths 40s. to 45s., turners 40s., fitters 40s. labourers 28s. and upwards. It is against such wages as these for hours varying from 51 to 54 per week that the A.S.E. have ordered a strike. It is in receipt of such wages that we are finding out men do not care to stay at work more than two to four days a week. We know for a fact that men are taking work, and sticking to it for a couple days only. They then leave, and idle again, and get another two days' job in a few days. This sort of thing cannot last, and will not last, nor is it desirable that it should last; but while it is continuing the trade of the country is going to ruin, and when the end does come it is pretty certain that all who went out will not go in again, nor will the keen demand for men which existed before the strike be found to exist after it. All the scheming of the A.S.E. will not enable a lot of bankrupt employers to pay wages.

THE HACKNEY VESTRY AND ITS CONSULTING ENGINEER.

The Hackney Vestry, at a special meeting held on Wednesday evening, received the report of a special committee which had been going into the correspondence with Mr. F. H. Medhurst. The committee reported that they had considered a letter from that gentleman, and at his request granted him an interview, with the result that the committee wrote agreeing to recommend the Vestry to formally appoint him consulting engineer in regard to the scheme under the electric lighting order, subject to his agreeing to the following conditions:—

In the event of the said scheme not being carried out by the Vestry, that he waives all claims whatsoever upon the Vestry for commissions and fees, and that he be paid only for the work actually done by him as already agreed.

That he withdraw and cancel his letter to the Vestry Clerk, dated November 5th, 1896.

That in the event of the Vestry parting with their electric lighting order, that he is to have no claim whatsoever upon the Vestry for fees or commissions.

To this Mr. Medhurst replied, absolutely agreeing to the terms, subject to it being understood that the Vestry appoints him in regard to any electric lighting scheme (whether combined with refuse destructor or not) which it may carry out under the electric lighting provisional order. The Special Committee, therefore, recommended that a resolution be passed by the Vestry in accordance with the terms of their letter to Mr. Medhurst, and his acceptance of the conditions contained in the same.

On Wednesday the whole history of the subject of the relations existing between the Vestry and Mr. Medhurst was gone into. The discussion lasted a couple of hours, but the greater part of that time seemed to us to be wasted in bickerings, personalities, and points of order, and the introduction of extraneous matter. Hackney vestrymen are not all gifted with oratorical talent, and consequently the speeches, with one or two exceptions, were about up to the mark of Vestries generally. The point which gave rise to so much discussion was whether or not Mr. Medhurst had really received an appointment as electrical engineer. The majority of the Committee which went into the matter is convinced that the Vestry is liable to Mr. Medhurst, and that certain correspondence and receipts are proofs of such appointment. The Vestry held that if an appointment was made it was unintentional, but the facts had to be looked at just as they stood, and the Committee recommended measures whereby the Vestry could wash their hands of the past by appointing Mr. Medhurst for any future scheme. Against this proposal much was said, for the members were of opinion that it would "bind posterity" to engage Mr. Medhurst for any scheme, even if proposed by some other engineer. The idea of the Committee in making its present recommendations was to avoid being drawn into a lengthy law suit by Mr. Medhurst, and many Vestrymen thought this was the better plan, but after an amendment had been put to the meeting and lost deferring the matter for six months, a division on the main question showed the voting to be as follows:—In favour of the Committee's report, 23 votes; against, 33 votes. The report was therefore rejected, and the matter accordingly remains where it was some months ago.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending Sept. 14th, 1896.	£	s.	Week Ending Sept. 14th, 1897.	£	s.
Adelaide. Teleg. mat.	614	0	Antwerp	13	0
„ Teleph. mat.	29	0	Bangkok	260	0
Amsterdam	115	0	Beira	1,032	0
Antigua	10	0	„ Teleph. mat. ...	40	0
Antwerp	20	0	Bombay	12	0
Bombay	135	0	„ Teleph. mat.	24	0
Brisbane	35	0	Boulogne	11	0
„ Teleph. mat.	70	0	Brisbane	50	0
Calcutta...	848	0	Buenos Ayres	200	0
Cape Town	542	0	Calcutta...	26	0
Colombo	13	0	Cape Town. Teleg. mat.	1,890	0
„ Teleg. mat.	27	0	Delagoa Bay	11	0
Durban	198	0	„ Teleg. mat.	448	0
East London	585	0	Durban	116	0
Fremantle	1,076	0	Flushing	74	0
Ghent	10	0	Gibraltar	280	0
Hamburg. Teleg. mat.	321	0	Gothenburg	7	0
Hong Kong	12	0	Lisbon	94	0
Kurrachee	75	0	Madras	19	0
Madras	40	0	Melbourne	50	0
Melbourne	102	0	„ Teleg. mat.	1,356	0
„ Teleg. mat. ...	283	0	Odessa	750	0
Penang	29	0	Perth	191	0
Perth	85	0	Piræus. Teleg. mat. ...	124	0
Rangoon. Teleg. mat.	15	0	Port Elizabeth	768	0
Santos. Teleg. mat. ...	32	0	Rio Janeiro	325	0
Singapore. Teleg. mat.	139	0	Santos. Teleg. mat. ...	44	0
Stockholm	65	0	Shanghai	105	0
Sydney	596	0	Singapore	7	0
Wellington	340	0	Sydney	658	0
„ Teleph. mat.	294	0	Wellington	7	0
Yokohama	10	0	Yokohama	30	0
Total	£6,552	0	Total	£8,932	0

Foreign Goods Transhipped.

	£	s.		£	s.
Melbourne	8	0	Adelaide. Teleph. mat.	39	0
Stockholm. Teleph. mat.	8	0			
Total ...	£16	0	Total	£39	0

Auction Sale.—Messrs. Wheatley Kirk, Price & Goulty have been instructed by the trustee in Paterson & Cooper, European Works, Pownall Road, Dalston, London, N.E., to sell by public auction the entire contents of the works, including plant, machinery, stores, &c. See our "Official Notices" this week for fuller particulars.

Brown v. The I.E.S. Accumulator, Limited.—On Wednesday, in the Vacation Court, Mr. Justice Byrne, on the application of Mr. Chitty, made an order for the appointment of a receiver and manager in the matter of the I.E.S. Accumulator, Limited. This was a debenture-holders' action, and no opposition was offered by the company.

Catalogues Wanted.—Messrs. Rolfe & Co., of 21, Louise Buildings, Johannesburg, will be glad to receive new catalogues of fittings, accessories, and general engineering lists.

Change of Address.—The British Electric Traction Company, Limited, announce that on and after the 20th inst. the offices of this company will be at Donington House, Norfolk Street, Strand, W.C.

Demurrage Claim.—Messrs. W. T. Bridges & Co., of Fenchurch Street, E.C., had 25 cases of electric fuses sent to the Victoria Docks. Owing to the extremely dangerous nature of the fuses, the Midland Railway Company said that they must be removed within six hours, according to their regulations. The firm did not remove them for some time, and accordingly demurrage was charged at the rate of 5s. per ton per hour. The company charged £4 8s. 9d., and they claimed for that amount before Mr. Commissioner Kerr last week, when judgment was given in their favour with costs.

Electric Construction Company, Limited.—Our Wolverhampton correspondent says that this company, whose works are situated at Bushbury, near Wolverhampton, are about to make considerable extensions in order to meet the growing demands of the trade. The company have 750 employés at the present time, and it is proposed to extend the accommodation in all the branches, so as to employ about 250 more hands.

Fined.—Frederick Paskin was fined 2s. 6d. at the City Summons Court on Tuesday for allowing an electric cab to stand longer than necessary outside St. Paul's Station, Queen Victoria Street, E.C. The cab was stated to have been standing there 1½ hours, causing considerable obstruction. The excuse made was that the cab waited there at Mr. Manville's order; but as that gentleman had now gone to America, he could not be called to give evidence.

Gas.—An explosion at Gordon Road, Peckham, on 9th inst. did considerable damage to house property and injured several persons.

A gas explosion at Goldstone Villas, Hove, some days ago did damage to the premises and injured three people.

On 9th inst., a serious gas explosion occurred at Holburn Street, Aberdeen.

Rucker v. New & Mayne, Limited.—In the High Court, on Wednesday, before Mr. Justice Byrne, Mr. Russell applied for the appointment of a receiver and manager in the matter of New and Mayne, Limited. This was a debenture-holders' action, and no opposition was made to the proposed order by the company. His Lordship made the appointment as asked, with leave to act at once, and to borrow a sum not exceeding £1,500 for the purposes of the business.

Switch Blocks.—Mr. Wm. Middlemiss, of Nesfield Street, Bradford, who makes a speciality of switch blocks of polished wood, sends us a few specimens of these articles, which certainly are very excellently finished, and will look well in any establishment where they are employed. All sizes are kept in stock in large quantities.

ELECTRIC LIGHTING NOTES.

Aberystwyth.—The Town Council has referred to the Public Lighting Committee the question of the unsatisfactory lighting of the town. It is stated that the arc lamps do not give anything like 2,000 C.P.

Aldrington.—The District Council has resolved to apply for an electric lighting provisional order.

Arbroath.—An electric Light company has written to the Town Council saying that it is applying for an electric lighting order and will soon commence with the lighting of the district. The Council accordingly unanimously refused to consent to the proposal.

Ayr.—In submitting the financial statement to the Council on Monday, it was stated that the electric lighting account showed a large deficiency on the year's working.

Ballymena.—The Town Commissioners have appointed a Committee to confer with Messrs. Caruth & Son, solicitors, in regard to certain details relative to the proposed lighting of Ballymena with electricity.

Battersea.—At the recent meeting of the Vestry Mr. Brown asked for the minutes of the Electric Lighting Committee, stating that he believed that the Committee had made an appointment which would not meet with the general approval of the Vestry. The clerk said that if the appointment of Mr. Hammond was referred to, nothing had been done, and no appointment could be made without the consent of the Vestry. As Mr. Brown persisted in going into the matter, the Vestry considered it in committee, several Vestrymen and some strangers in the gallery protesting against the secrecy.

Bradford.—It is expected that the extension of the Corporation's Electricity Works in Valley Road will be in working order by the end of the autumn. The demand for electricity has considerably increased, and the old works would not, in the coming winter, be able to generate enough electricity to supply the city.

Bristol.—At last week's meeting of the Electric Light Committee, the question of the provision of electricity as a motive power, and the loan of alternating current motors on the simple hire or hire-purchase system, was raised. The secretary, Mr. Prosser, submitted a report he had drawn up on the subject with prices of electricity for motive power and heating. With regard to price, there would be a fixed charge of £1 10s. per quarter per kilowatt demanded, and a charge of 2d. per unit for the electricity consumed. This rate would not be subject to any discount whatever, but no charge would be made for the necessary meter. The committee adopted the scale of charges, and decided to lend meters on the simple hire or hire-purchase system. The engineer, Mr. Faraday Proctor, informed the committee that two of the new boilers had arrived, and one of them was already in position. The other machinery was in an advanced state.

Burton-on-Trent.—The Town Council is reducing its charges for electric current.

Cardiff.—Alderman Carey, chairman of the Lighting and Electrical Committee, stated incidentally at the monthly Council meeting on Monday, that the committee had now turned the corner, and the receipts from electric lighting were not only sufficient to meet the expenditure, but also to relieve the rates to the extent of ½d. in the £.

Carnarvon.—The Town Clerk is to advise the Town Council what steps to take in applying for an electric lighting provisional order, and whether to apply for such powers themselves, or let a company come in.

Colwyn Bay.—The state of electric lighting affairs here has come to a noteworthy pass, and an error has been committed by the District Council, which if that body were well advised it would lose no time in remedying. The proposal was made that Messrs. Fawcus & Clirehugh be appointed consulting and electrical engineers to the Council. An amendment was made deferring the question. The voting was for the original motion 4, for the amendment 4 (including one *director* of the gas company). The chairman gave his casting vote for the amendment, and everything said about the injustice of the gas director voting against a rival illuminant had no effect with the chairman, who in response to a member who disputed his ruling replied "I do not care what you think; Mr. Porter is returned here to vote, and it is not for me to rule his vote good or bad."

Coventry.—At the meeting of the City and County Council on Tuesday, the Electric Light Committee presented their amended report for extensions to works and mains at an estimated cost of £31,000. The original estimate was £37,000, but as stated last week, the report was referred back, and the proposals for street lighting cut out, and the area of mains reduced. Alderman Hill, Chairman of the Committee, regretted having had to leave out the street lighting, and quoted the experience of Portsmouth, where street lighting was found to be a great advertisement, and a splendid load for long hours. Mr. West, vice-chairman of the Committee, ridiculed the idea that the extension of the electric lighting system would seriously affect the gas undertaking, and appealed to the Council not to starve the enterprise. Mr. Lee moved an amendment that the report be referred back again, with the view of limiting the expenditure to £20,000, and Alderman Andrews, Chairman of the Gas Committee, also strongly criticised the financial aspect of the electric light department. The principal objections were to carrying the mains to outlying districts, but it was stated the Committee reserved to themselves discretionary power, and that mains would not be laid unless there was a sufficient demand to pay for them. The amendment received support from half a dozen members, and the report, on being put, was adopted.

Edinburgh.—The Town Council last week went into the question of lighting Portobello by electricity. By 24 votes to 17 the scheme was adopted.

The Council also adopted a motion, of which notice had been given by Messrs. Mackenzie & Waterston, for the formation of a new electricity station in the east of the city, and for the introduction of new machinery, so as to increase the power of the present station for the year 1898-9. Mr. Mackenzie, in moving the proposal, said that within a year they would require new machinery in the present station, and that they must have a new station within the next two years.

Epsom.—Col. W. R. Slack has held a Local Government Board inquiry in respect of the application of the District Council to borrow £2,600, a moiety of which is required in connection with an electric lighting scheme, for which the Council have obtained a provisional order from the Board of Trade.

Garston.—At last week's Council meeting correspondence was submitted from the Board of Trade with regard to the revocation of the order granted to the Liverpool and District Electric Lighting Company to supply electric light in the Garston district; also copy of a letter sent on behalf of the Council to the Electric Lighting Company, calling their attention to the terms of an agreement they had entered into binding themselves not to oppose the Council if they took steps to supply electricity to their district themselves.

Gosport.—The District Council has appointed a committee to consider the advisability of installing the electric light for the town and parish.

Harrogate.—The Town Clerk has been authorised to apply to the Local Government Board for a loan of £17,500 for extending the electric lighting works.

Hastings.—The Lighting Committee had received a communication from the solicitors to the Hastings and St. Leonards Electric Light Company, stating they understood a difficulty had arisen in consequence of the contract with the Corporation for sale and purchase of the company's undertaking, not having provided for the alteration to buildings necessitated by the new boilers and other plant which had to be fixed, and also by reason of the omission to provide for the expenditure on mains and transformers for the ex-

tension of business, suggesting that the contract should be amended in those particulars, as it was evident that such work was the necessary consequence of the new plant to be supplied, and submitting a memorandum which they had prepared for carrying their suggestion into effect. The committee recommended that the terms of the memorandum be assented to. This was agreed to by the Council.

Johannesburg.—From a lengthy report which has been issued by the Town Engineer of Johannesburg, Mr. Charles Aburrow, for the year ending December 31st, 1896, we abstract the following facts regarding the electric lighting of that town. It is interesting to note that the average price for gas was 18s. 9d. per 1,000, and for electricity 1s. 5¾d. per unit:—"During the year the overhead electric light wires have been increased by about 20 miles (360 poles erected), making the total length of wires at the end of the year about 42 miles. At the end of 1895 the customers of the department numbered 117. During the year they have been increased by 120, making the number 237 at present. At present about 14,000 lamps, equivalent to 8 C.P. each, are connected with the mains, and about 8,500 are awaiting connection. During the year the public lighting has been increased by 100 incandescent electric lamps, making a total of 123 at present, equal to 300 8 C.P. lamps, and by 21 arc lamps of 2,000 C.P. nominal. The total number of units generated during the year was 400,978, and they were distributed as follows:—

Sold to private consumers	282,304
Used for public lighting	12,878
Used at work	22,736
Unaccounted for	83,060
Total	400,978

The average price obtained per unit sold was 1s. 5¾d. The following additional plant, &c., has been put down during the year:—Two 100 H.P. nominal boilers erected with chimney, &c. Five Willans engines and alternators complete, 45 kilowatts capacity each. Two direct-driven exciters, with Chandler's engines, being in duplicate. One independent steam driver condenser and Worthington feed pump. Two arc lighting dynamos. One enlargement of switchboard and conduit to arrester house. One enlargement of arrester house, and about 70 Wurt's patent arresters fixed."

Rotherhithe.—At the last Vestry meeting two proposals respecting electric lighting were brought up for consideration. Mr. Warden-Stevens offered to report to the Vestry on the subject, and advise in obtaining a provisional order, and his letter was ordered to lie on the table. A letter was read from the solicitors of the County of London and Brush Provincial Electric Lighting Company, asking for the formal consent to their application for a provisional order. The clerk was instructed to write asking the company what streets they proposed to include in their compulsory area.

Warrington.—The Town Council has resolved to apply for a provisional order for electric lighting. Some of the Councillors had hoped to hear something on the subject from a Committee appointed some time ago to consider it.

Keswick.—The District Council has decided to advertise the electric lighting order for sale, as the Company which proposed to purchase it cannot at present raise sufficient money for the purpose.

Leamington.—The Town Council unanimously resolved on 13th inst. to apply for a provisional order for electric lighting.

Lowestoft.—At a meeting of the Lowestoft Town Council, on Tuesday night, it was resolved to authorise the General Purposes Committee to take the necessary steps for procuring a provisional order from the Board of Trade for the electric lighting of the borough. The General Purposes Committee will prepare report and plans, &c., for the next meeting.

Maidenhead.—A proposal to apply for a provisional order was on the agenda for the last Council meeting, but was not discussed, as a further motion will be made in a month's time.

Motherwell.—The Council last week decided to provide an electric lighting installation for the district. The Lighting Committee will visit various towns, including Glasgow, Edinburgh, and Ayr, before deciding as to system.

Ossett.—On the recommendation of the General Purposes Committee, the mayor has been authorised to call a special meeting next month for the purpose of authorising an application to the Board of Trade for an order or license authorising the local authority to supply electricity for public and private purposes.

Portrush.—The Gas Company is to be asked to reduce the price of gas, and the clerk is to look into the question of raising a loan for the purpose of lighting the town by either gas or electricity.

Redditch.—A Syndicate wants to know if the District Council will sell its electric lighting powers. Matter referred to Committee.

Shoreditch.—The Vestry has approved of the action of the Lighting Committee in purchasing three motor generators for sub stations at £616 each. Alterations are to be made at the substations to take these generators, and the contract for the work placed with Messrs. Atherton & Dolman. The *Contract Journal* says that the Lighting Committee has accepted the tender of Messrs. T. Stubbins & Son for the removal of clinker and fine ash from the dust destructor yard at 1s. 5d. per ton. The charge for public lighting is to be 5d. per unit.

Shrewsbury.—On Monday the Town Council adopted a report of the Finance and General Purposes Committee, in which they stated that they had considered the report of Messrs. Kincaid, Waller & Manville, the electrical engineers employed to report upon the Shropshire Electric Light and Power Company's works, and they recommended the Council to negotiate for the purchase of the same, and to proceed to obtain the necessary power by provisional order. The Town Clerk was instructed to negotiate with the company with the view to purchasing the undertaking, and report to the Finance Committee. The net value of the undertaking is reported at £14,580, without the goodwill.

Southampton.—The Electric Lighting Committee report that Mr. Manville advises that, having regard to the increasing demand for electricity in the town proper, and the supply which would be required for the new cranes to be erected by the Harbour Board, it was now desirable that two additional steam engines and low tension dynamos should be provided, with accessories, on the low tension side of the new engine house at a cost of £3,200. It was decided that Mr. Manville should include the additional engines, &c., in the specification which he was preparing. Mr. Manville also stated that it would be necessary to hire machinery during the time of the transfer of the plant from the temporary building to the new building, in order that to prevent any cessation of the supply, and suggested that provision should also be made in the specification for such hiring as was necessary. This suggestion was adopted, as was also a further one, to the effect that with a view to avoid opening the roads a second time, and to obviate the inconvenience to the inhabitants, provision should be made for constructing the necessary ducts and feeders in connection with the supply of electricity to the tramways at the same time as the ducts for carrying the lighting mains. The Town Clerk had been instructed to advertise for tenders. The Electric Lighting Committee decided that in lieu of appointing a clerk of the works in connection with the contract, the resident engineer (Mr. Lee) be appointed to superintend the works, and that he be paid £50 for his services. At the meeting of the Council the latter recommendation was strongly opposed, and eventually the report was allowed to stand over for further consideration.

Southend.—The Town Council have resolved to consider a scheme for lighting the town with electricity, the cost of which will be £15,000.

Spain.—Additional plant is about to be put down at the central station at Alicante, and orders have just been given out for a 125 H.P. Otto gas engine, for a Dowson gas producer plant, and for a 90-kilowatt dynamo.

St. Pancras.—In bringing up the report of the Electricity Committee at the last Vestry meeting, Mr. Menzies drew attention to the great increase in the number of applications for current. An interim balance-sheet will be issued shortly.

Sunderland.—At the last Council meeting a letter was read from the Sunderland Trades' Council, protesting against the recommendation of the Lighting Committee that the electrical engineer be authorised to take two premium pupils at a fee of £50 for two years each, such premium to be divided equally between the Corporation and the electrical engineer. The letter stated that the proposal of the Committee was contrary to the spirit of the times, when the property of the town, such as the lighting stations, ought to be open equally to the sons of the poor as the children of the rich. Alderman Bruce, in moving the adoption of the report, said that the adoption of the item relating to premium pupils would be a saving to the ratepayers, as those who entered would do the work for which they were now paying salaries. Councillor Summerbell moved the rejection of the minute, chiefly on the ground that the Council should not place a barrier in the way of providing opportunity for the sons of any ratepayer to enter the profession of electrical engineer. They knew that clever lads were being turned out from their Higher Grade schools, and it was unfair to prevent them from taking part in such advantages. On behalf of the various trades in the town, he appealed to the Council to act on a democratic principle, and by sending the report back, make it possible for the cleverest boys in the town to enjoy such advantages as the electric station offered. Councillor Dr. Jago seconded, and endorsed all that Councillor Summerbell had said. After further discussion, the minute was withdrawn.

West Hartlepool.—The Council has decided to purchase 3½ acres of land in the vicinity of Burn Road for a site for the destructor, and for the erection of a generating station for electric lighting purposes.

Wolverhampton.—Our local correspondent informs us that at Monday's monthly meeting of the Town Council a report was submitted by the Lighting Committee recommending that as the balance sheet to June 14th showed a profit of £225 odd on last year's working, the charges for electrical energy be reduced with a view to adding to the number of consumers. The maximum demand system of charging was adopted, the price to be fixed at 6d. per unit on a maximum demand of two hours daily, and 3d. per unit beyond. The Committee was authorised to expend a sum of £370 14s. 2d. in providing the necessary "demand indicators" for the adoption of this system.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Bristol.—The Staple Hill electric tram line to Fishponds is to commence operation next week. The Board of Trade inspection was to be held early this week.

Douglas (I.O.M.).—The Town Council held a special meeting last week to consider the report of the Continental tramway deputation to which we made brief reference in our last issue. The discussion lasted for 2½ hours and the matter was then adjourned for a month. A memorial was presented by 32 owners and occupiers of property on the Loch Promenade, who submitted "that the substitution of electric traction by overhead wires for the present horse traction *would be illegal*," and would introduce an element of danger to the lives of the public who frequented the promenade. "It would also militate against the handsome appearance of the finest marine promenade in the world." We have read over the remarks made against electric traction, and particularly the overhead trolley, by some of the members of the Douglas Corporation, and we cannot think that certain of these gentlemen have looked into the matter in an unbiassed manner. Neither can we congratulate them upon the accuracy of their details, nor the sense of certain of their statements which seem to us the outcome of rabid flights of the imagination. However it is to be hoped that when the discussion is reopened the Council will not be led away by the fallacious arguments of some of the speakers who appear to know little about the matter, but will adopt the recommendation—almost unanimous, though not altogether so—of the Committee.

Dover.—In the *London Gazette* for September 10th, are published in full the bye-laws and regulations which have been made by the Corporation in connection with the electric tramways. They deal mainly with (1) the rate of speed to be observed by drivers; (2) the distances at which carriages using the tramway shall be allowed to follow one after the other; (3) the stopping of carriages using the tramway; (4) the traffic on the road in which the tramway is laid. Drivers are to see that cars are not driven at a speed of less than four miles an hour on the average, and not exceeding eight miles an hour. They are also to see that every car shall be so driven that it shall not follow a preceding car at a less distance than 100 yards.

Dublin.—Although the main agreement between the Dublin Corporation and the Tramways Company in reference to the use of electric traction in the streets of the city of Dublin is sealed and accepted by both sides, yet, says the *Irish Daily Independent*, a few minor details, such as switchings, &c., have to be decided upon. The engineers of the Corporation and the Tramways Company are in negotiation over these matters, and it is expected that all the points under discussion will be satisfactorily settled this week. The Tramway Company have agreed to pay the Corporation a rental of not less than £10,000 a year for permission to run electric trams over the existing tramway lines in the city. It is also stipulated that an additional rent of £500 per mile is to be paid for newly constructed lines in future. The set income of £10,000 is not accurately the income the Corporation will eventually derive from the Tramways Company, because there will be an additional taxation of the existing lines, which will produce a rate of something betwen £3,000 or £4,000, so that the total income the Corporation will receive from the existing lines will be nearly £14,000. The overhead wire system will be used in all cases, and the Corporation will be entitled to use the poles for electrically lighting the streets if they decide to do so. In narrow streets, such as North Earl Street, where there is always heavy traffic, and only a single line, the tramway authorities will have a good deal of difficulty in using electric haulage. In such cases they have an idea of dispensing with poles, and fixing the electric wires on the tops of the houses. This, of course, would entail a good deal of additional expense, but it is the most feasible course to adopt.

Mr. W. M. Murphy, director of the Dublin United Tramways Company, and Mr. W. Anderson, secretary and manager, have left Ireland for New York. It is understood, says *Freeman's Journal*, that their visit to America is for the purpose of examining the most approved and effective electric motor appliances, with a view to the introduction into this city of electric in place of horse traction on the Tram Company's system.

Electrical Cabs.—Mr. W. C. Bersey sends us a few particulars of the working of the electrical cabs since the inauguration on August 19th last:—"So far everything has been most successful, and the fact that the Scotland Yard Authorities, after having refused licenses to several other kinds of motor carriages, have, after a severe test, duly licensed the cabs, is in itself a proof of their efficiency. A part of the Scotland Yard test is to run each cab up and down the Savoy Hill in the Strand, this hill being the steepest gradient in London. At different times, and on several occasions, journeys have been made to and from Hampton Court, Kempton Park, Lewisham, Sandown Park, Norwood, Croydon, Crystal Palace, Crouch End, &c., and the steep hills to be met with on some of the roads running to these various places, such as Highgate Hill, Sydenham Hill and Richmond Hill, have given no trouble whatever. Further, twelve of the cabs have been plying for hire in and around the City and West-End of London, and the takings of the cabmen—amounting as they do to about 150 per cent. more than the takings of an ordinary hansom—show very well the public favour with which the cabs have been received. With regard to the 'opposition' of the London Cab Trade Council, which numbers some 50 or 60 members, we have to place side by side the fact that the great Cab-Drivers Union of London, numbering some 10,000 members, are distinctly in favour of the new cab."

Electric Locomotives.—The *Daily Chronicle* says that the electric locomotive will be an accepted and working factor of the Western Railway of France from the beginning of next year's summer service. The time-tables of the second half of May will be startling enough, for the distances between Granville, Angers, Laval, and other far-off stations from Paris are to be covered at the rate of more than 65 English miles an hour.

Glasgow.—The Scotch daily papers give some particulars and a rough sketch of the electric cars which are to be used on the Springburn route. The car is designed by Mr. O. Young, the tramway manager. It is a composite car to accommodate 46 passengers, its main features being an open and a closed end, with the entrance platform in the centre, but all under one roof. The "open" compartment is open at the sides only, all the ends being closed.

The Tramways Committee inspected the new car on the 7th inst., and luncheon followed.

Sheffield.—Several members of the City Council complained that the contracts for rails, fish plates, bolts and nuts, &c., for the tramways, had been given to firms in other parts of the country, instead of Sheffield.

Spain.—An electric tramway has just been completed and put in operation in the town of San Sebastian.

TELEGRAPH AND TELEPHONE NOTES.

Dublin Telephones.—A new telephone exchange is approaching completion here. It is expected to be open for use early in December.

Postal Telegraphs.—Among the list of Civil Servants who, though having attained the retiring age of 65 years, are to continue in service for a longer period, we observe the name of Mr. J. F. Ducloy, superintendent at the Post Office (Central Telegraphs Office), who will be retained until April 1st, 1899, an extension of nearly three years.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Cyprus-Latakia	July 23rd, 1897 ...	...
St. Vincent-Santiago... ...	Sept. 2nd, 1897 ...	...
Mozambique-Lourenco Marquez	Sept. 4th, 1897 ...	...
Bolama-Bissao	Sept. 13th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ..	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Siberian landlines—		
Blagowestschensk-Khabarowka	Sept. 12th, 1897 ...	...
Saigon-Bangkok	Sept. 14th, 1897 ...	...

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be sent in plain language.

April 21st, 1897.—The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

April 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

September 3rd.—Eastern Company announce that traffic for South and East Africa is subject to serious delay.

September 12th.—All telegrams for Guatemala are subject to censure at San José.

"Temporarily Interrupted"!—To all who are interested in South Africa the continual interruptions to the cables, which were laid with the idea of affording a means of telegraph communication with the Cape, furnish a source of chronic complaint which cannot but be considered most justifiable. The average newspaper reader, if indeed he give a thought to the subject at all, is content to congratulate himself that he is saved the need of posting himself in South African news. We can even imagine that those who have the keenest interest in the political situation of the Colonies may at times be grateful when the cables are reported as broken down. However that may be, it is obvious that the frequent interruptions to these telegraph cable systems must be very much to the disadvantage of those involved in the many mining companies in the Transvaal; which are now going through a crisis in their development. We have, at frequent intervals, laid before our readers information as to the highly unsatisfactory condition of the cable routes in question; and we find as time goes on that, instead of improving, things grow

steadily worse and worse. On looking into the details of interruption, we find that since about Christmas, 1895—the time of the "Jameson raid,"—the main lines of the two cable routes to South Africa have been broken down on not less than 17 occasions (the East coast route ten, and the West coast of Africa route seven times), these interruptions having lasted nearly seven months out of the 21 which have elapsed since the time of the "raid." If the subsidiary cables along these two routes be taken into consideration we find that there have been altogether 23 interruptions, and that for about ten months some one or other, at times more than one, of the cables has been useless. We have not included in the above those frequent occasions on which notice of "delays in transmission" have been given. The condition of affairs here indicated can be looked on as little short of scandalous, especially when it is borne in mind that during the period we are now dealing with the companies interested in these cables have received considerably more than £200,000 from the English, and various other Governments in the form of subsidies and guarantees. In the face of the lesson which we have here, it is astonishing to learn that a scheme has been put forward, under which some of the cables above referred to would form part of a system to Australia, *via* the Cape, Mauritius, &c., which proposed scheme it is suggested will do away with the necessity for a line across the Pacific uniting Australia with Canada. It is something to find that those concerned in the existing cables to Australasia have recognised the necessity of an alternative route, but such steps as they have hitherto taken to improve matters have not been of a nature to inspire much confidence in their methods. We are advised against putting a new patch in an old garment, and it seems that as far as communication with the Cape is concerned the garment requires complete renewal, and so far we quite agree that a new cable, *via* Ascension and St. Helena would be an advantage; at any rate this would afford a third line to replace the two frayed and knotted strings which the Cape at present has to its bow. How long, however, a cable laid *via* St. Helena is likely to last we are not prepared to say. To those who have given any attention to the matter, it is clear that the Pacific affords the best route to Australia. After this Pacific cable has been completed, and the much required new line has been laid to the Cape, there would be an advantage in connecting the Cape with Australia by a fresh route; as in that case messages from South Africa could be sent to England *via* Australia and the Pacific, should the new Cape line collapse as frequently as its predecessors.

Note.—The East Coast route is at present interrupted.

The Glasgow Telephone Inquiry.—The Telephone Committee of the Corporation met representatives from the suburban burghs and county authorities, within the radius of the Glasgow Telephone Exchange, for the purpose of arranging what action should be taken in view of the Government inquiry to be held in the city at the end of the month on the question of the municipalisation of telephones. Those invited to the conference were the burghs of Govan, Partick, Kinning Park, Pollokshaws, and Rutherglen, and the counties of Lanark, Renfrew, and Dumbarton. It is stated that the Corporation have received about 3,000 favourable replies from firms and private individuals to their circular suggesting a Corporation Telephone Exchange. It is expected that the inquiry will last about a week.

The Post Office Telephone Charges.—The Postmaster-General has issued notifications of reduced rates for private wires and telephone exchange wires which will come into operation on October 1st. The Department reserves to itself the right to vary these new rates under special circumstances. It is also notified that telephone wires to the Central Telegraph Office can be used by the renters for communicating with Paris over the London-Paris telephone and for communicating with towns on the inland trunk wire system, on payment of the appropriate fee for each conversation. Reduced rates for private wires have been fixed for the provinces as well as London. As examples of the new rates, it may be mentioned that the cost for a Post Office telephone exchange wire, within a radius of one mile from the Exchange, will in future be for places of business £10, and for private houses £9 per annum, and for places within a radius of half a mile the rentals will be respectively £8 and £7.

The "Silvertown."—This week the ss. *Silvertown*, which is at present engaged laying a cable for the French Government from Brest across the Atlantic to Cape Cod, has been at Barry Dock.

The Telegraph Wire Export Trade.—Although there was rather a large falling off in the export trade of this country in telegraph wire and apparatus connected therewith during the past month as compared with July last, yet on the whole the August shipments were rather above the average for that month, they having amounted to £93,475 as compared with £136,547 in the preceding month, and only £65,176 in August last year. The trade this year to date shows a considerable improvement over the two preceding months. The figures showing a total of £700,748 for the first eight months of 1897, as against £461,578 in the corresponding period of last year, and only £338,169 in the first eight months of 1895.

Trunk Telephones in Ireland.—On 9th inst., the Dublin, Cork and Limerick telephone line was opened for public use. This also brings the three places into direct communication between London and other English cities.

Wireless Telegraphy Experiments at Dover.—The series of experiments in wireless telegraphy were commenced on Tuesday, says the *Daily Mail*, the operations being conducted under the direction of Mr. Gavey, the principal technical officer of the General Post Office. A party of the telegraph section of the Royal Engineers are engaged in connection with the operations. The principal centre of observation and the point at which the transmitting instruments are placed is Fort Burgoyne, on the Deal Road, just north of Dover Castle. The utmost secrecy is maintained in regard to the experiments, and during the operations the fort is closed, no access being allowed except with the special permission of the authorities. The present experiments are being conducted in the interest of the General Post Office. The experiments, which are likely to extend over a considerable period, were made with varying success.

CONTRACTS OPEN AND CLOSED.

OPEN.

Belize, British Honduras.—October 20th. The District Board of Belize invite tenders for the lighting, by electricity, of the town. System proposed "three wire or neutral wire," comprising boilers, engines, dynamos, accumulators, mains, &c. Particulars from Mr. A. R. M. Simkins, M.I.E.E., care of F. Otto, Esq., Tower Chambers, Moorgate Street, E.C. See our "Official Notices."

Bray.—September 27th. Tenders are being invited by the Township Commissioners for the supply of 15 alternating current arc lamps, globes and carriers. See our "Official Notices."

France.—September 30th. Tenders are being invited by the French Minister of Commerce for the concession and working of an electric tramway in the grounds on the left bank of the Seine, of the 1900 Exhibition, during the period the exhibition is open. The line is to be about 4½ kilometres, and is to be ready for operation by January 15th, 1900. Particulars of the scheme may be had from the Ministère du Commerce, Paris.

France.—Tenders are being invited by the French Post and Telegraph Authorities in Paris, for the supply of 200 tons of galvanised iron wire 4 mm. diameter, and 130 tons of galvanised iron wire 3 mm. in diameter. Tenders to the Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Halifax.—September 20th. The Corporation want tenders for a tramway switchboard. Electrical engineer, Mr. Wilmshurst.

Hull.—November 5th. The Corporation invite tenders for the electrical equipment of their tramways, to the extent of about 9 miles double track and ½ mile single track. The contract will not be divided and will include engines and generators, switchboards, feeders, poles, brackets, trolley wire, rail bonding and all accessories, also the first instalment of cars (15 motor cars and 5 trailers). Further information can be obtained from our "Official Notices." City engineer, Mr. A. E. White. City electrical engineer, Mr. A. S. Barnard.

Italy.—September 28th. The Direzione Géneralé delle Ferrorie Meridionali, of Florence, are inviting tenders until the 28th inst. for the supply and erection of a 40-ton electric crane. Tenders to above.

Llandudno.—September 22nd. The District Council wants tenders for certain works in connection with the electric light and dust destructor scheme, including the supply of water tube boilers, condensing plant, &c., steam engines and dynamos, switchboard, battery, travelling crane, underground mains, arc lamps, posts, &c. Particulars from Mr. A. H. Preece, 39, Victoria Street, Westminster.

Nice.—September 16th. The Municipal Council are inviting tenders for the lighting of the Opera House by electricity. Particulars at the Commercial Department of the Foreign Office. Tenders to Le Conseil Municipal, Nice.

Norway.—September 22nd. Tenders are being invited by the Norwegian State Railway Administration for the supply of telegraph and telephone materials. Particulars at the Commercial Office at the Foreign Office, Whitehall, S.W., from 11 a.m. to 6 p.m.

Plymouth.—October 2nd. From our "Official Notices" particulars may be obtained of tenders which are invited by the Corporation for overhead trolley line posts, brackets, tramcars, trucks, motors, trolley arms, &c., in connection with the borough electric tramways which are to be laid down. Borough electrical engineer, Mr. J. H. Rider.

Port Elizabeth.—September 21st. The Town Council invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town to private houses, stores, &c., for terms of 5, 15, 20, 25 or 30 years respectively.

Queensland (Aus.).—November 15th. The Municipal Council of Ipswich, Queensland, is inviting tenders for the supply and erection of the following electric lighting plant, &c.:—Tubular boilers, pipes, pumps and heaters, alternators and exciters, switchboard, high and low tension mains, junction boxes, transformers, &c. Specifications, and all particulars as to conditions, &c., may be obtained from Messrs. Gordon & Gotch, St. Bride Street, Ludgate Circus, London, E.C., and tenders have to be forwarded to the Town Clerk (Mr. Albion Hayne), Council Chambers, Ipswich, Queensland.

Roumania.—November 15th. Tenders are being invited by the Municipal Authorities of Ploesti, for the concession for the establishment and working of an electricity generating station in the town, during a period of 40 years for private and public lighting and also for power transmission purposes.

Russia.—September 30th. Tenders are being invited by the Municipal Authorities of Penza for the concession for the construction and working of a system of tramways in the town, to be worked either by electricity or other mechanical power.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Sofia.—September 22nd. The Secretary of State for Foreign Affairs has received a despatch from the Acting British Consul-General at Sofia, stating that the municipality of that town invite tenders for—(1) The supply of electric current to light the streets as well as public and private buildings in the town and the supply of electric power; and (2) The construction and working of electric tramways in the town and suburbs. Tenders will be received at the offices of the municipality of Sofia. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Switzerland. — September 25th. Tenders are being invited by the Municipal Authorities of Lausanne for the concession for the establishment and working of a central electricity supply station in the town. Tenders to be sent to, and particulars may be obtained from, Le Conseil Municipal de Lausanne.

West Ham.—September 20th. The Council wants tenders for the wiring for electric lighting of the Technical Institute and Public Library at Romford Road, Stratford, E.

Whittingham, (Lancs.).—September 20th. Tenders are invited for electric lighting and plant required at the new hospital and reception wards at the County Asylum, Whittingham, for the Lancashire Asylums Board. Particulars at the offices of Messrs. Simpson and Duckworth, architects, Richmond Chambers, Blackburn, or at the offices of the consulting engineers, Messrs. Fawcus and Clirehugh, Temple Chambers, Brazennose Street, Manchester.

CLOSED.

Derby.—Messrs. S. Z. de Ferranti, Limited, have obtained the contract for the extension plant at Derby.

France.—The French Post and Telegraph Authorities in Paris have just given out contracts for no less than 1,110 tons of copper wire as follows:—Messrs. Lazare, Weiller & Co., Paris, 160 tons; the Usines Mouchel, 300 tons; M. A. Grammont, of Pont-de-Cheruy, 100 tons; La Compagnie Française des Metaux, Paris, 200 tons; La Société de Franche-Comté, of Besancon, 50 tons; La Société Française d'Electro-Metallurgie, Paris, 100 tons; La Compagnie du Bi-Metal, 100 tons; and La Société de Pontigband, 100 tons.

Newport.—Tenders are recommended for acceptance for the new plant required for the extension of the electricity work, the total being £12,129 10s.; and that of Mr. D. W. Richards, Newport, amounting to £6,400, has been accepted for erecting the buildings.

Worcester.—The Council having authorised expenditure upon additional plant at the Electricity Works, the Electricity Committee recommended the Council to accept the tender of S. Z. de Ferranti, Limited, for the supply of the following plant: (1) Switch gear at £436 16s. (2) Low tension apparatus for exciter circuits at £160, and (3) cables and junction boxes, &c., at £60. This was agreed to as was also a proposal to accept the tender, amounting to £531 3s., of G. E. Belliss & Co., Limited, for the supply of a high speed engine (£440), a coil clutch, &c. (£85), and spare parts (£6 5s.).

NOTES.

Strange Cause of a Cable Interruption.—A correspondent writing from Rio de Janeiro, under date August 25th, 1897, informs us that on August 22nd, whilst the telegraph ship *Norseman* was engaged picking up cable off Cape Frio, she brought up a whale which had become entangled with the cable. The cable had not parted, but the conductor was interrupted. The whale had probably been there some two or three weeks, judging by its condition, its head breaking off during picking up. It had been much worried by sharks. It measured 14 feet across its tail. The depth of water there is 66 fathoms, soft mud and clay bottom. Lat. 23°—17½′ S., long. 41°—40½′ W.

Gas and Electricity in Great Yarmouth.—At the eighteenth general meeting of the Eastern Counties Gas Managers' Association at Ipswich, on Thursday last week, Mr. A. W. Ranken, the electrical engineer to the Great Yarmouth Corporation, and Mr. C. E. Sayer, were present in the capacity of visitors, but assisted in the discussions. Mr. W. G. Carpenter, of Great Yarmouth, contributed an important paper, entitled, "Electricity and Gas in Great Yarmouth." He gave an exhaustive description of the Yarmouth Electricity Works, and the plant. In the discussion which ensued, the President (Mr. J. S. Jolliffe, of Ipswich), said he thought it was now generally accepted that gas companies did not suffer from the competition of electricity, as was thought would be the case some 20 years ago. It was possible for almost the smallest trader to generate electricity for his own use at a very much cheaper rate than that at which any company could supply him. In Ipswich, they had a tradesman who had put in an electric lighting plant for himself at a cost of under £150, generated his light at under 3d. per Board of Trade unit, whilst another tradesman with a larger installation (gas engines being used), with an outlay of £400 got electric light at 2½d. per unit. Mr. Ranken said if gas engines had to be run all day for the sake of one or two lights, the expense would be more than it would be were the supply taken from a company or corporation. Mr. W. R. Chester (Nottingham) said the increase in the consumption of gas at Nottingham last year was equivalent to four times the output of the electric light station. Mr. W. G. Child (Romford) said his experience was, that the electric light was more calculated to assist than injure gas companies. In Romford one private installation, carried out by means of gas engines, had increased the customers' gas account by three times to what it was previously. Mr. J. Carter (Lincoln) said he had had similar experience. Mr. D. F. Goddard, M.P., Mr. G. A. Biddell, Mr. E. C. Sayer, and Mr. E. W. Smith (Chelmsford) continued the discussion on somewhat similar lines, there being a disposition, however, on the part of the last named to give warning against electricity being too lightly regarded as a competitor.

Cathode Rays in Space.—Prof. Goldstein has been making some remarkable experiments at the Royal Astronomical Observatory, Berlin, which are likely to throw a great deal of light on the theory of comets and other astronomical and meteorological phenomena. It is well known that when a solid body is interposed in the path of the cathode rays in a vacuum tube, that it becomes itself a secondary source of cathode rays upon which the primary cathode appears to exercise a repulsive action. In Goldstein's theory, the sun is the primary cathode and sends out cathode rays to immense distances into space, and the solid or gaseous nucleus of a comet is a secondary cathode which also sends out cathode rays always directed away from the sun; these secondary cathode rays forming the visible tail of the comet. Goldstein has been able to reproduce in his vacuum tubes nearly all the characteristic phenomena of comets' tails, and to explain some curious forms and movements which have defied previous theories. Goldstein's experiments are not yet complete, but he hopes to be able to explain by this theory many other phenomena such as the red flames and prominences which are observed round the sun during total eclipse; and also the magnetic storms, earth currents, aurora borealis, and thunderstorms upon our earth, which have long been suspected to be greatly influenced by solar action.

Personal.—Mr. J. H. Ridley, manager of the electrical works of Messrs. Muirhead & Co., of Prince's Street, Westminster, has been awarded the medal of the Royal Humane Society for having rescued Mary Baxter, who fell into 12 feet of water on the River Nene, at Tansor, near Oundle.

The Northampton Institute.—The programme of this institute for the 1897-8 session has been issued, giving particulars as to staff, subjects taught, social announcements, &c. In the applied physics and electrical engineering department the principal, Dr. R. Mullineaux Walmsley, is lecturer, Mr. C. V. Drysdale being chief assistant and senior lecturer, and Mr. E. T. Martin performing the duties of demonstrator and instructor in instrument making.

"Archives of the Röntgen Ray."—This quarterly publication contains a number of plates illustrating the latest results of Röntgen photography, and the first report of the proceedings of the newly formed Röntgen Society. The president of the society, Prof. S. P. Thompson, gives an excellent short address on the theories of the Röntgen rays, showing that none of these theories as yet have received experimental proof, and that consequently we know about as much now about the real nature of the Röntgen ray as we did when it was discovered. Dr. Hedley gives a historical survey of the work that has been done with the Röntgen ray, more especially in its application to surgery and medicine. We are sorry to see that some of the writers still continue to use such barbarous terms as "radiography." The council of this society ought to take an early opportunity to decide upon a rational nomenclature for the new science.

The Glasgow Committees.—We understand that the Tramways Committee, by 15 votes to 2, has resolved upon the adoption of the proposal of the Lord Provost, whose speech we printed last week, to amalgamate the Electricity and the Tramways Committee. The Electricity Committee by a small majority declined to adopt the proposal. The matter came before the Town Council yesterday, Thursday, and we learn as we go to press that the amalgamation proposal was rejected.

Train Lighting.—It is stated that an experiment in the electric lighting of railway carriages is being carried out by the London and North-Western Railway Company on its suburban line between Euston and Watford. Each carriage is treated independently, having its own dynamo driven by gearing from one of the axles, and a set of accumulators to provide current when the train is not in motion. The carriages on the trains in question are entirely new, and are of the most improved type. Each is 50 feet in length, and is carried on two pairs of four-wheeled bogie trucks.

Football.—The football enthusiasts employed in the glass-blowing room at the Incandescent Electric Lamp Company's Brook Green Works, were engaged in friendly strife on Saturday with the Ponder's End glass-blowers. In the result, after an exciting game the Brook Green Works representatives vanquished their opponents by 4 goals to 3.

Boult's Method of Electric Signalling.—We have on two or three occasions referred to Mr. Boult's method of signalling, and in our issue of January 1st we dwelt very fully upon the system. Mr. Boult has recently effected certain improvements, and a few days ago we had the pleasure of seeing the apparatus working at the works of the India-Rubber Company at Silvertown. There was no doubt that under the laboratory conditions prevailing at the time of our inspection the apparatus worked in the most rapid and certain manner, and if the same reliability were to be obtained in actual practice, the system would no doubt achieve considerable success. It will no doubt be remembered that a trial of Mr. Boult's system was made on a train of the Manchester, Sheffield, and Lincolnshire Railway. This train, however, never travelled at a greater rate than 30 miles an hour, and further trials are to be made with the system on a train having a speed of 60 miles. Actual practice can alone decide the real utility of Mr. Boult's system, and if the inventor succeeds in overcoming the difficulties that are bound to arise, he will have achieved much.

South-West London Polytechnic Institute.—The new session here commences on September 28th. Full details of the arrangements, including engineering and chemical industries' classes, will be found in our "Official Notices" this week.

City of London College.—The Michaelmas term commences on September 27th. Classes will be held in magnetism, electricity, sound, heat, light, mathematics, chemistry, and other science subjects. See our "Official Notices."

Appointment.—Mr. H. J. Jeykyn, assistant electrical engineer at Halifax, has been appointed to a similar capacity by the Tramways Committee of the Leeds City Council.

The Electro-Harmonic Society.—The first concert of the season takes place next Friday, September 24th, at the St. James's Hall, when it is expected that a goodly company will be present to enjoy the excellent programme which has been prepared. The following is a list of the artistes:—Mr. George Aspinall and Mr. R. E. Miles, A.R.A.M.; solo-violoncello, Mr. B. Parker; solo pianist, Mr. A. E. Izard; humorous recitations, Mr. W. G. Churcher; humorous sketches, Messrs. R. Ganthony and G. Schneider.

CITY NOTES.

Epstein Electric Accumulator Company, Limited.

The creditors and shareholders of the Epstein Electric Accumulator Company, Limited, of Victoria Street, Westminster, and Milton, Staffordshire, met last Friday at the Carey Street offices of the Board of Trade, before Mr. A. S. Cully, assistant receiver in charge of the liquidation proceedings instituted recently.

In commenting upon the case the Chairman said the company was registered in July, 1891, with a nominal capital of £101,000, made up of 100,000 ordinary and 1,000 founder's shares of £1 each. The ordinary shares were entitled to a preferential non-cummulative dividend of 15 per cent. per annum, and the founder's shares to one half of the net profits after payment of such dividend. The promoters of the company were Woodhouse & Rawson, Limited, and Mr. Ludwig Epstein, and its objects were to acquire certain patents and patent rights relating to inventions and improvements in the manufacture and use of storage batteries, also to carry on the business of electrical engineers. The purchase consideration was fixed at £71,000, payable in shares as follows, viz.:—To Mr. Epstein 31,500 ordinary and 450 founders' shares, and to Messrs. Woodhouse and Rawson, Limited, 38,500 ordinary and 550 founders' shares. The purchase agreement provided that Woodhouse & Rawson, Limited, should advance to the company £7,500 at 5 per cent. interest for working capital as and when required, such advance to be repaid out of profits after providing for working expenses and a payment of 10 per cent. of the net profits to Mr. Epstein, who was to become managing director. That agreement was subsequently modified with a view to leaving a portion of the money for working capital. The original directors were Mr. Henry G. Rawson, Sir James Mackenzie, Bart., and Mr. Epstein. Then in August, 1891, Mr. F. L. Rawson was elected on the board, and on September 28th was elected chairman of the company. Sir C. W. F. Craufurd, Bart., was also elected a director on the same day. Mr. F. L. Rawson and Mr. H. G. Rawson resigned office in July, 1894, when Mr. Roger W. Wallace, Q.C., became a director, and in the following October Mr. Harvey Du Cros also joined the board, as did Mr. J. B. Martin in November, 1894. Mr. Wallace had since acted as chairman of the company. No prospectus was issued, but the directors went to allotment in October, 1891, when the 71,000 vendor's shares were issued, and various other shares were then and subsequently issued for cash to Sir C. W. F. Craufurd, Mr. H. G. Rawson and Sir J. Mackenzie. The remuneration of the directors was agreed at £100 per annum each, but in September, 1894, 300 guineas was voted to Mr. H. G. Rawson for services rendered. That money, however, had never been paid to him. Mr. Epstein acted as managing director until December, 1896, when he resigned, and was appointed consulting engineer with a seat on the board of directors. His remuneration as managing director was altered on several occasions, and was finally settled at £400 a year, in addition to £25 a year for each 1 per cent. paid in dividends to the shareholders. No dividend having been paid, Mr. Epstein had not received anything in respect of that portion of his remuneration. The company had apparently from the first been always in want of funds. In March, 1892, Messrs. Rawson, Epstein and H. G. Rawson, were appointed as a committee to consult as to the best way to raise further working capital. On their report it was resolved to create debentures for £10,000, but no immediate steps were taken in that behalf. Then in March, 1893, the company entered into an agreement with Woodhouse & Rawson United, Limited, for the issue of £6,000 first mortgage debentures bearing interest at the rate of 6 per cent. and charging the whole undertaking of the company. Part of the proceeds of that issue went in reduction of the debt owing to Woodhouse & Rawson United, and the company only received £2,500 in actual cash; but Woodhouse and Rawson further surrendered their rights to receive repayment of advances out of the first 5,000 shares issued by the company. Further shares and debentures were subsequently issued, the total issue being £6,000 first and £12,200 second debentures. A question might arise as to the priority of the two classes of debentures, and that would have to be dealt with in a debenture action now pending. On July 30th Mr. Northey, the secretary of the company, was appointed receiver and manager on behalf of the debenture-holders, and at the date of the winding-up order that gentleman was in possession of the property, and carrying on the business. The balance-sheets prepared by the company showed that a loss of £4,698 was made on the trading for the year ended July, 1892; a loss of £7,088 during the following year, and a loss of £5,841 for the period ended December, 1894. A profit of £7 8s. was made in 1895, but in 1896 there was a loss of £6,009. In all those balance-sheets the value of the patents was taken at the cost price. It was a peculiar feature of the case that while in 1892 the sales were only £2,182, and the loss was £4,698, the sales in 1896 were £20,089, and yet there was a loss

of £6,000. The statement of affairs showed total liabilities £25,973, of which £7,117 19s. were unsecured; the assets were valued at £6,520, and were covered by the debenture holders' claims for £18,200. The deficiency to the creditors was £18,826, and the total deficiency, as regarded shareholders, was £90,133. The directors had returned the value of the patents at £1,000 for a forced realisation, but were of opinion that if arrangements could be made to carry on the business, they possessed a much larger value. The company had entered into very large contracts for the supply of batteries to the Lancaster Corporation, the Kensington and Knightsbridge Electric Light Company, Limited, the War Office, the Admiralty, the Wolverhampton Corporation, and the Bradford Corporation. They alleged that they had recently experienced great difficulty in regard to the accumulators, in consequence of the importation of impurities during the course of manufacture, owing to the bad and impure state of the atmosphere at Milton, caused by some chemical works in the immediate neighbourhood. Heavy claims had been made upon the company in respect of defective batteries, and he (chairman) understood that experiments were now being made with a view to ascertaining whether the cause of the defect as given by the directors was the true cause. If the defect could be remedied, and efficient batteries manufactured, it was proposed to reconstruct the company, and under those circumstances it was advisable to appoint a liquidator and committee of inspection, to act on behalf of all parties.

Mr. Epstein and Sir C. Crauford addressed the meeting, and confirmed the chairman's statements as to the cause of the defects in the batteries manufactured at Milton, also as to the proposed reconstruction of the company in the event of the pending experiments being successful.

After some discussion, Mr. Northey, the secretary of the company, was elected as liquidator, to be assisted by the following committee or inspection, viz.: Mr. L. Epstein, Mr. C. Courtney (Ross, Courtney and Co., Limited), Mr. Joseph Kent, representing Messrs. Tooney and Sons, Aston), and Mr. J. Beardmore (Peddick & Beardmore), of Burslem.

The Brush Electrical Engineering Company, Limited.

The eighth annual report, to be presented to the shareholders at the general meeting of the company to be held at Cannon Street Hotel, London, E.C., to-day, states that the directors herewith submit the balance-sheet and profit and loss account for the year ended June 30th, 1897. The profit and loss account shows an available gross profit of £43,761 6s. 3d. After deducting maintenance, general charges and interest on debenture stock, there remains a balance of net profit of £18,962 4s. 5d. The directors recommend that this sum be applied as follows:—

	£	s.	d.
To Balance of dividend due to preference shareholders for year ended June 30th, 1895 ...	2,141	3	8
„ Dividend at 4 per cent. per annum on preference shares for the year 1896-7	7,200	0	0
„ Bonus payable to employés under profit sharing scheme	1,609	2	4
„ Reserve fund	5,000	0	0
„ Balance carried forward	3,011	18	5
	£18,962	4	5

The results of the year's working show a decided improvement over those of the previous year. Further administrative economies have been and are being effected, of which the accounts for the past year have not derived the full benefit. The directors are glad to report that the condition of the industry generally is steadily improving. Formal sanction to the reduction of the ordinary share capital authorised by the shareholders last November having been obtained, the balance-sheet is drawn in accordance with the reduced valuation of assets approved by the Court. Of the £76,770 4½ per cent. redeemable second debenture stock, the directors have decided to pay off £26,770. This amount has been drawn in accordance with the provisions of the trust deed, and will be redeemed on October 1st next. There will then be a sum of £50,000 second debenture stock outstanding. Capital expenditure to the extent of £11,348 5s. 8d. has been incurred during the year on extensions of buildings and plant at Loughborough; and further additions are now in progress. The directors consider this capital outlay justified by the large volume of orders now in hand, and the improving prospects of the company's trade. The company's works have been employed during the past year in the manufacture of electric lighting and traction plant, consisting of steam engines, alternating and direct current dynamos, and accessories; also of locomotives, cars, and other rolling stock. In the field of electric traction the company has secured important contracts, which are now in progress. The result of the year's operations enables a further distribution to be made to the employés under the company's profit-sharing scheme, the scope of which was extended in 1893 to include the company's workmen. Since then the sum of £4,753 6s. has been distributed among participants in cash, or invested in the provident fund on their behalf. In the opinion of the board, the scheme continues to work well in the interests both of shareholders and participants. The usual statement of the trustees to the fund is appended. During the year Mr. J. S. Raworth has resigned his position on the executive staff as joint manager and chief engineer, and has been elected to a seat on the board. Mr. R. Percy Sellon has been appointed general manager. Mr. A. H. Sanderson and Colonel F. G. Steuart are the directors who retire by rotation, and being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers & Co., also retire, and offer themselves for re-election.

Elmore's Patent Copper-Depositing Company, Limited.

The report of the directors for the year ended June 30th last, states that the business of the company has not only been well maintained during the past year, but has improved on the turnover for 1895-96. The accounts show that after keeping the plant, machinery, and buildings in thorough efficiency, and providing for contingencies, and after paying all working expenses, except interest on the Haigh Park Estate mortgage, and interest on capital borrowed under exceptional circumstances, the profit is £7,212, including £1,521 brought forward from last year. After defraying the interest, which is £779 more than last year, on borrowed capital, there remains a balance of £3,564 in hand. The directors regret that so large a deduction has to be made out of profit for the payment of high rates of interest, but hope that this will very soon be effectually remedied. The increase in the company's debenture charge is more than accounted for by the reduction in the amount due to creditors and by the increase in the company's assets. Extra capital was required for re-investment in debentures in connection with the copper mine concessions previously announced. As yet the accounts have only received a slight benefit from the arrangement, whereby the company can purchase its raw copper at a low price. Some delay has occurred in consequence of the mine having to be equipped with entirely new plant for treating and concentrating the ores, but on the whole the progress made at the mine has been very rapid indeed. The supplies are continuing to reach the works in increasing quantities, and the directors are pleased to state that the benefits which were expected to arise from this contract are commencing to be realised. Excellent progress in respect to the rapid method of operating the Elmore process has been made, and as regards its success the directors can fully confirm the assurances given at the general meeting on December 12th last upon this subject. Owing to its novelty, much time has been necessary to solve the various problems and details involved in its application, but the cost of these experiments is not borne by the company. The shareholders may confidently reckon that in this new invention they have acquired an asset of the most valuable description. This report and the accounts are issued at the present time for the purposes of information, and the general meeting will be held as soon as possible, of which due notice will be given. The directors hope at that meeting to submit details of the scheme of amalgamation between this company and Elmore's Wire Manufacturing Company, Limited; and, possibly, with other companies.

Isle of Man Tramways and Electric Power Company, Limited.—An extraordinary general meeting of this company was held at Douglas on Wednesday. The directors were authorised to increase the existing preference share capital of the company by a sum of £25,000, and to create and issue as a separate share capital under the Act authorising the construction of an electric tramway from Laxey to Ramsey 50,000 5 per cent. preference shares of £1 each, and 50,000 ordinary shares of £1 each. It was stated that the new line would act as a feeder to the existing undertaking, and promised to be a paying concern.

The Direct Spanish Telegraph Company, Limited.—The board has decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income tax, on the ordinary shares, both for the half-year ended June 30th, 1897, and payable on October 1st next.

Automatic Telephone Company, Limited.—Certificates for fully paid-up shares of 5s. each are now ready to be exchanged against certificates, balance tickets, and transfer receipts of the old syndicate (Apostéloff Automatic Téléphone Parent Syndicate, Limited), as notified by the circular sent out by the liquidater thereof on 5th inst.

Stock Exchange Settlements.—Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to:—Edison and Swan United Electric Light Company, Limited—£200,000 four per cent. debenture stock.

Babcock & Wilcox Company, Limited.—The directors have declared a dividend on the ordinary shares of 10 per cent. for the six months ended June 30th.

Western Union Telegraph Company, Limited.—The directors have declared the usual dividend of 1¼ per cent.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 12th, 1897, were £879; week ending September 13th, 1896, £835; increase, £44; total receipts for half-year, 1897, £9,906; corresponding period, 1896, £10,016; decrease, £110.

The Liverpool Overhead Railway Company. The receipts for the week ending September 12th, 1897, amounted to £1,451; corresponding week last year £1,262; increase, £189.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 12th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,440.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Sept. 8th.	Closing Quotation, Sept. 15th.	Business done during week ended Sept. 15th, 1897. Highest.	Lowest.
149,900	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5 — 6	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	56 — 59	58 — 60	58⅝	58
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	103½ — 104½	105 —106	105⅝	103⅜
3,038,920£	Do. do. Defd.	Stock	...	...	...	11¼ — 11⅜	12¼ — 12⅜	12⅛	11½
130,000	Brasilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15 — 15½	...	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	180 —185	178 —183 xd	...	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106½—107½	107 —108	107⅜	107¼
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	⅞— ⅞	⅞— ⅞	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	8½— 9½	8½— 9½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18½— 19½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 11	10 — 11	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000	50	4½%	4½%	4½%	103 —106%	103 —106 %	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	10 — 10⅛	10 — 10⅛	10⅜	10⅛
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	16¾— 17¼	16¾— 17¼	17 5/16	16⅞
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	17½— 18½	17½— 18½	...	...
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	101 —104	101 —104	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	129 —132	130 —135	132	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	7⅛	17½— 18	17½— 18	17 15/16	17 9/16
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 —103	99 —103	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	128 —131	129 —132	...	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 —103	99 —103	...	...
69,200£	Do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	103 —106	103 —106	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110%	108 —111 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½— 12	11½— 12	11⅞	11⅝
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	16¾— 17¼	16¾— 17¼	17⅛	16⅞
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝%	10 %	10⅜	26½— 27½	26½— 27½	26⅝	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105 xd	102 —105	104½	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	54 — 57	54 — 57	...	...
100,000£	London Platino-Brasilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	104 —107 xd	105 —108	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000...	5	4 %	4 %	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	5½%	6⅜— 6⅝	6⅜— 6⅝	6⅝	6 7/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6 1/16	6
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —110	105 —110	107½	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	2/16— 1 1/16	2/16— 1 1/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	..	...	...	135 —140	136 —141	139½	139
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 4	3⅝— 4¼	3 15/16	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	101 —106	102 —107	105⅜	105
15,609	West African Teleg., Ltd., 7,501 to 23,189	10	nil	4 %	nil	5 — 6	5 — 6	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —105 xd	103 —106	...	...
64,256	Western and Brasilian Teleg., Ltd.	15	3 %	3 %	2 %	9 — 9½	9 — 9½	...	...
33,129	Do. do. do. 5 % Pref. Ord.	7½	5 %	5 %	5 %	7 — 7½	7 — 7½	7¼	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2½— 2⅝	2½— 3	2 7/16	...
382,230	Do. do. do. 4 % Deb. Stock Red.	Stock	...	...	...	101 —104	101 —104	103½	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	1 %	¾— 1½	⅝— 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10 — 10½	10 — 10½	10⅝	10½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8 — 9	7½— 8½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,809	100	5 %	5 %	5 %	105 —108	106 —109	107½	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	7 %	7 %	7%	106 —110	106 —110	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105 xd	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	12½— 13½	12½— 13½	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6⅝	...
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277	5	5 %	5 %	5 %	10 — 10½	10 — 10½	10 7/16	...
60,000	Do. do. do. 4½ % Deb. Stock Red.	Stock	...	4½%	4½%	110 —113	110 —113	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	24½— 25½	25 — 26	25½	25⅜
10,000	Do. do. Prov. Certs.	5	...	...	...	... ...	23½— 24½	24¼	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	17 — 18	17 — 18	17⅝	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	130 —135	130 —135	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12⅜— 13½	12⅜— 13½	12 13/16	12⅞
20,000	Do. do. do. 6% Pref., 40,001—60,000	10	...	6 %	6 %	15½— 15⅝	15½— 15⅝	15⅝	15½
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	9 — 9½	9 — 9½	...	...
10,000	Do. do. 7 % Cum. Pref.	5	...	...	...	10⅜— 11¼	10⅜— 11¼	11 3/16	11 1/16
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000	10	3 %	4 %	5 %	17 — 18	17 — 18	17⅜	17⅛
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem.	10	...	...	...	16 — 17	16 — 17	...	...
220,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —122	118 —122	121½	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	16½— 17½	16½— 17½	...	17
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red.	Stock	...	...	...	103 —106	103 —106	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	5 %	7 %	9 %	14½— 15½	14½— 15½	15½	15⅜

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Sept. 8th.	Closing Quotation Sept. 15th.	Business done during week ended Sept. 15th, 1897. Highest.	Lowest.
20,000	British Electric Traction	10	...	...	...	13¼ — 13⅜	13 — 13½	13⅜	13¼
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	2½%	...	...	⅞ — 1⅛	⅞ — 1⅛	1	15/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅛ — 1⅜	1⅛ — 1⅜	1 1/16	1⅛
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	103 —107 xd	103 —107	106½	103½
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	94 — 98	94 — 98	...	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	10⅛	9¼
143,106	Do. do. do. £6 paid ...	10	...	...	...	5½ — 6¼	5⅝ — 6¼	...	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1¼ — 1⅜	1¼ — 1⅜	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4⅛ — 4⅜	4⅛ — 4⅜	...	...
630,000£	City and South London Railway	Stock	1⅛%	1 1/16%	1 1/16%	66 — 68	66 — 68	67½	66½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ — 2	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2⅛ — 2⅜	2⅛ — 2⅜	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	4 — 4½	4 — 4½	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	6 %	1⅝ — 2	1⅝ — 2	1 15/16	1⅞
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2⅜ — 3⅛	3 — 3½	3⅛	3⅛
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅝ — ⅞	⅝ — ⅞	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	½ — ¾	⅜ — ⅝	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	9 — 11	9 — 11	..	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½xd	18½ — 19½	19½	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18 — 19	18 — 19	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	21 — 22	21 — 22	22	21½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅜%	2⅜%	10⅜ — 10⅝	11¼ — 11½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16 — 16½	16 — 16½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	37 — 40	36 — 39	...	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ — 11¼	10⅜ — 11¼	11	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 60% for 1890.

Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7½‖ 1890—6%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9½.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company, 4½% Debentures of £100, 109—111.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13½—14½; 1st Preference Cumulative 6 %, £5 (fully paid), 8¼—8⅝. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅞—2.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8—8½. Dividend for 1896—6 %.

Bank rate of discount 2 per cent. (May 13th, 1897).

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—TORONTO, 1897.

SOME TESTS ON THE VARIATION OF THE CONSTANTS OF ELECTRICITY SUPPLY METERS, WITH TEMPERATURE AND WITH CURRENT.

By G. W. Donald Ricks, A.C.G.I., A.I.E.E.

(Section G.)

The general object of the tests to be described in this paper was to afford a means of studying the behaviour of direct-current electricity supply meters with regard to variations in the accuracy of their indications under varying conditions of temperature, current and potential difference.

Some of the more important meters were put through a series of tests which aimed at ascertaining—

1. How the accuracy of the meter depended upon the current at various constant temperatures, all other conditions being maintained constant.

2. How its accuracy depended on the potential difference at constant current and temperature.

The first of these tests was carried out at three different temperatures - namely, about 2° C., 18° C. and 40° C., which may be fairly taken as the extreme and mean ordinary working temperatures. From the results of this test the effect of change of temperature at constant potential difference and current was ascertained.

The second test is, of course, only applicable to energy meters. It was made at the maximum current and at atmospheric temperature, the pressure being varied from about 10 per cent. below to 10 per cent. above the normal value.

The above tests were carried out at the City and Guilds Central Technical College upon each of the following meters, obtained direct from the makers, and not opened or in any way altered before testing.

These, it will be seen, fairly represent the principal types of direct current meters now in general use in this country.

Name of meter.	Maker's number.	Normal pressure.	Maximum current.	Declared constant.
Elihu Thomson	80,711	100	10	1·0
Schuckert	10,717	110	15	0·5
Ferranti	17,876	...	25	1·0
Perry	401	...	20	2·0
Chamberlain & Hookham	6,973	...	25	1·0

Apparatus and Method of Testing.

In carrying out these tests it was necessary to have some means of controlling the temperature of the air surrounding the meter, and for this purpose a thermal case of the following construction was employed:—

The inner tank, T_1 (fig. 1), is of copper, 14 inches square by 20 inches deep, and is fixed within another similar tank, T_2, by means of wooden distance pieces, w, w, leaving a space of 2½ inches between the two tanks at the sides and bottom; the top, however, was covered by a mahogany lid, L, provided with a large window of ¼-inch plate glass. The whole was then placed in a wooden case, 28 inches square and 32 inches high, the intervening space being filled up with sawdust to retard, as much as possible, interchange of heat and consequent change of temperature. For the same reason the top was covered with cotton wool, except for a small portion of the window through which observations were made.

For the higher temperature tests, the space between the copper tanks was filled with water at a temperature rather above 40° C., and this was maintained constant by passing steam into the water, thus supplying heat in place of that lost by radiation, &c. The rate at which this steam was passed in was governed by a Reichert's automatic thermostat, s, which regulated the supply of gas in the steam generator. Using this apparatus, no difficulty was experienced in keeping the temperature of the air in the inner tank constant to within ½° C.

The low temperature, on the other hand, was obtained by substituting for the hot water a freezing mixture of salt and ice, and it was found that in this case no regulation was necessary, because

after the freezing mixture had been in for several hours, a steady condition was reached, after which the air in the inner tank showed no appreciable rise of temperature for two or three hours.

The intermediate temperature taken was that of the atmosphere at the time of testing, and after closing up the thermal case no greater variation occurred than in the other cases.

The rest of the apparatus, and its arrangement, is shown in fig. 2, where M, is the meter under test, B, a battery of accumulator cells, B_1, a variable carbon resistance, and B_2, a variable mercury resistance for

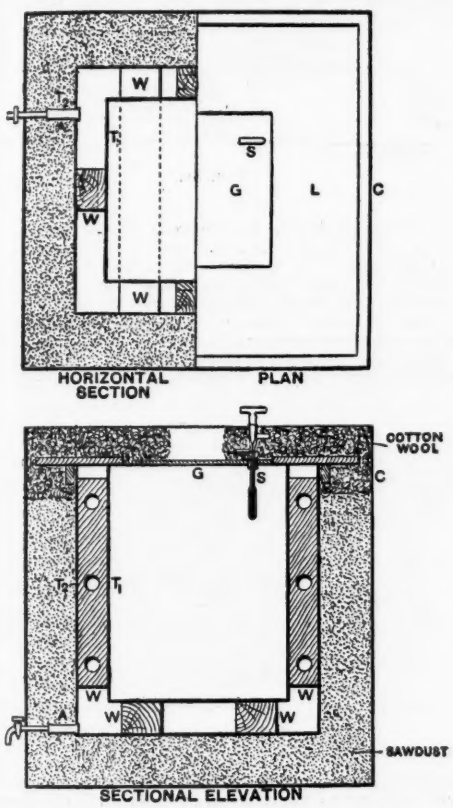


Fig. 1.

close regulation of the larger currents used. Currents down to 10 amperes were measured by means of a Kelvin balance previously standardised by the copper deposit method. It was not suitable, however, for currents below 10 amperes, and for such currents it was therefore replaced by the arrangement shown in fig. 2, and consisting of a sensitive d'Arsonval galvanometer, G, connected in series with a variable resistance, B_3, to the ends of a platinoid strip, P. This arrangement, after being carefully calibrated, constitutes a very sensitive ammeter possessing the very desirable property that its sensibility can be adjusted according to the magnitude of the current to be measured. It was calibrated relatively by the potentiometer

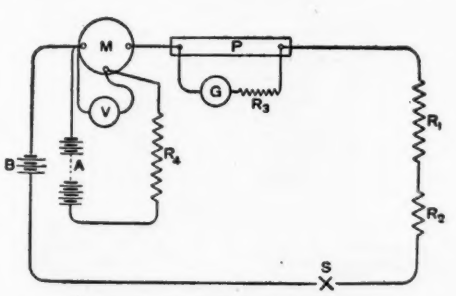


Fig. 2.

method, and absolutely by comparison with the Kelvin balance. In the case of ampere-hour meters this completes the arrangement, but for energy meters it is necessary also to energise the shunt-windings by keeping their terminals at the proper potential difference. This was effected by means of the battery of small accumulator cells, A, with a regulating resistance, B_4, in circuit. This potential difference was measured on an Ayrton and Mather deadbeat astatic station voltmeter. In the second set of tests, however, in which it is required to determine the effect of varying the potential difference, a reflecting voltmeter of the d'Arsonval type was employed.

The accuracy of supply meters is most conveniently studied by experimentally ascertaining to what extent the constant or multiplier differs from its declared value under different conditions. By plotting the result as a curve of variation one obtains a clear indication of the behaviour of the meter as regards the accuracy of its readings. The multiplier referred to is the number by which the amount indicated by the meter must be multiplied to give the true value in watt hours or ampere hours as the case may be. Hence the constant or multiplier may be defined as the ratio of the true value to the indicated value. To obtain the actual value of this constant experimentally, much time and labour can be saved by observing the revolutions of the armature instead of taking the dial readings in the ordinary way, for since they are connected simply by multiplying mechanism, their motions are proportional. All that is necessary is to determine once for all the number of revolutions of the armature

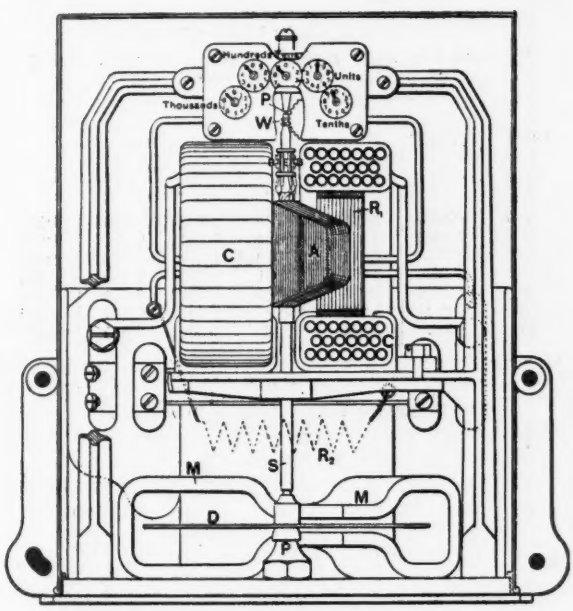


Fig. 3.

which correspond to the registration of one unit on the dial.

Let a = number of revolutions of the armature per unit registered on dial.
K = constant or multipler.
A = current in amperes.
V = potential difference in volts.
T = time in hours during which A might flow.
N = number of units registered in time T.
w = speed of armature in revolutions per second.

Then

$$a = \frac{3{,}600\ w\ \mathrm{T}}{\mathrm{N}} \text{ and } \mathrm{N} = \frac{3{,}600\ w\ \mathrm{T}}{a}.$$

In the case of watt-hour meters:—

$$\text{By definition } \mathrm{K} = \frac{\text{true watt-hours}}{\text{registered watt-hours}} = \frac{\mathrm{A\ V\ T}}{\mathrm{N}},$$

substituting for N

$$\mathrm{K} = \frac{\mathrm{A\ V\ T}}{3{,}600\ w\ \mathrm{T}} = \frac{a}{3{,}600}\frac{\mathrm{A\ V}}{w},$$

and

$$w = \frac{a}{3{,}600\ \mathrm{K}}\ \mathrm{A\ V}.$$

If K′ = the declared value of K,
w' = speed of armature when the meter is registering accurately,

$$w = \frac{a}{3{,}600\ \mathrm{K}^1}\ \mathrm{A\ V}.$$

$$\frac{\mathrm{K}}{\mathrm{K}'} = \frac{\dfrac{a\ \mathrm{A\ V}}{3{,}600\ w}}{\dfrac{a\ \mathrm{A\ V}}{3{,}600\ w'}} = \frac{w'}{w}$$

$$\mathrm{K} = \mathrm{K}^1\frac{w'}{w}.$$

The constant, a, having been first carefully determined, values of w' for different currents are calculated and tabulated or plotted for use.

Exactly the same method is applicable to ampere-hour meters, the only difference being that the quantity, V, does not occur.

In testing, therefore, there are in general three quantities to be measured, viz., current, potential difference and speed, the constant, a, being of course determined once for all for each meter.

The current and potential difference were measured and regulated

as already described, the speed of the armature was observed by noting, by means of a stop watch, the time taken for a convenient number of counted revolutions. The interval of time measured was never taken less than five minutes, so that the percentage error in w would be very small. In all cases the meter was allowed to run for a minute or two after each change of speed before any observation was taken, and the determinations of k for each point were repeated until concordant results were obtained.

Symbols used in the Tables.

w = speed of armature in revolutions per second.
K = constant (determined experimentally).
K^1 = declared constant.
A = current in amperes.
V = potential difference in volts.
a = number of revolutions of the armature per unit registered on the dials.

Table I.—*Elihu Thomson Meter.*

Maximum current, 10 amperes. Pressure, 100 volts. $a = 2$. $K^1 = 1$. Current varied.

Current A.	At − 1° C.		At 18° C.		At 38° C.	
	w	K	w	K	w	K
0·5	0·0225	1·236	0·0234	1·186	0·0237	1·17
1	0·0483	1·150	0·0492	1·129	0·0526	1·055
2	0·1028	1·081	0·1070	1·040	0·1132	0·983
4	0·2106	1·056	0·2241	0·993	0·235	0·945
6	0·3160	1·055	0·3360	0·994	0·354	0·942
8	0·422	1·056	0·448	0·991	0·471	0·945
10	0·523	1·061	0·556	1·000	0·585	0·951

Table Ia.

Pressure varied. Current = 10 amperes.

V	w	K
90	0·501	0·999
95	0·528	1·000
98	0·546	0·999
100	0·556	1·000
102	0·567	1·000
105	0·586	0·997
110	0·612	0·999

Table II.—*Schuckert Meter.*

Maximum current 15 amperes. Pressure 110 volts. $a = 1$, K = 0·5. Current varied.

Current A.	At − 4° C.		At 20° C.		At 41° C.	
	w	K	w	K	w	K
1	0·0577	0·530	0·0597	0·512	0·616	0·496
2	0·1178	0·519	0·1225	0·499	0·1256	0·487
5	0·2975	0·514	0·3110	0·492	0·3180	0·482
7	0·4160	0·515	0·4290	0·499	0·442	0·485
10	0·5910	0·518	0·6105	0·5015	0·625	0·489
12	0·7065	0·519	0·7300	0·5025	0·754	0·487
15	0·8925	0·516	0·9205	0·499	0·946	0·486

Table IIa.

Pressure varied. Current = 15 amperes.

V	w	K
100	0·546	0·510
105	0·574	0·509
108	0·590	0·509
110	0·599	0·510
112	0·6125	0·509
115	0·627	0·510
120	0·645	0·509

Elihu Thomson Meter.

This meter may be regarded as a form of electro-dynamometer so arranged that, instead of merely indicating power, it integrates it with regard to the time, and so measures the amount of energy that has passed. The general principle of all such meters is that a small fraction of the power to be integrated is employed to produce motion in an armature. If the velocity of the armature can be made exactly proportional to the whole power, then the number of revolutions of the armature in any time is a correct measure of the total energy that has passed.

In fig. 3, C C are two coils of thick conductor which carry the main current. The field thus produced is proportional in strength to the current, and in it is placed the armature, A, which is drum wound, without any iron in its core; its windings form part of the high resistance pressure circuit. Since there is no iron in the magnetic circuit, the driving torque thus produced is proportional to the product of current and pressure, and if the retarding torque could be made strictly proportional to the speed this would be sufficient; but solid friction at the bearings introduces a disturbing effect which is overcome, first by making the bearing friction as small as possible, and also by compensating what remains by means of a permanent driving torque, in addition to that already mentioned. Solid friction may be considered as being very nearly constant throughout the

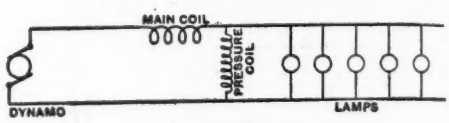


Fig. 3A.

range of speed employed. So the extra driving torque must be independent of the speed. It is produced by placing two fixed coils, B_1 B_1, of fine wire in the pressure circuit, and by connecting this circuit to the lamp side of the series coils, so that both the shunt and main currents pass round these windings (fig. 3A). The pressure circuit then consists of these two fixed coils, the armature, and an added non-inductive resistance, B_2, which brings the total to above 3,000 ohms. As the meter is designed for use on either direct or alternating-current circuits, it is important that the self-induction of

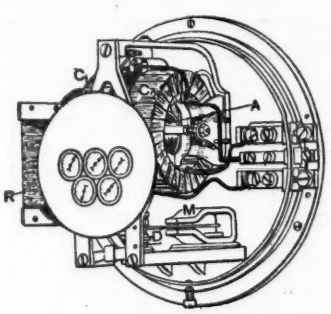


Fig. 4.

the pressure-circuit should be comparatively small, consequently the non-inductive part, B_2, forms the greater part of the whole resistance. Connection is made with the armature windings by means of a small silver commutator, E, at the top, and two lightly-pressing spring brushes, B, B, with silver contact pieces. Fixed to the spindle at its lower end there is a large copper disc, D, rotating in a non-uniform but constant magnetic field, supplied by two or three permanent magnets, M M. The reaction between the Foucault currents induced in the disc, and the magnetic field producing them, gives the required

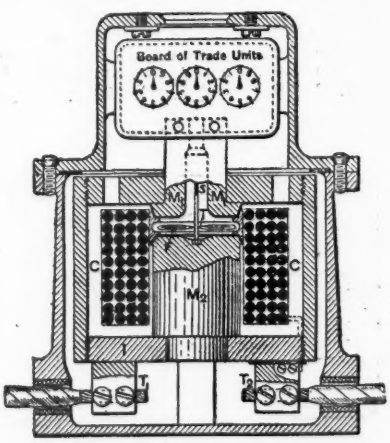


Fig. 5.

retarding torque proportional in magnitude to the velocity. The counting mechanism gears into a worm on the spindle at its upper end; the dials are usually direct reading in kilowatt hours, but in some sizes multiplication by a simple constant is necessary. In this meter solid friction is reduced to a minimum by having a delicate jewelled bearing, P, at the lower end of the spindle. It is provided with a spring arrangement to prevent injury from vibration, and it can be lowered out of contact when the meter is being moved. Very light pressure of the brushes is sufficient to give good electrical contact, and the upper bearing is, of course, unimportant, being little

more than a guide. What solid friction remains is in great part neutralised by the permanent torque already referred to.

The law of this meter is comparatively simple, and may be expressed as follows:—

Let A = main current.
V = potential difference.
w = speed of the armature.
a = a constant depending on windings, &c., of series coils.
b = " " " " armature.
c = " " " " coils $\mathrm{B_1}$ $\mathrm{B_1}$.
r = " " " solid bearing friction.
f = " " " brake field.

Then Driving torque $= a\,\mathrm{A}\,b\,\mathrm{V} + c\,\mathrm{V}\,b\,\mathrm{V}$.

Retarding torque $= f^2 w + r$.

For steady motion

$$a\,b\,\mathrm{A}\,\mathrm{V} + b\,c\,\mathrm{V}^2 = f^2 w + r.$$

Now if bearing friction is exactly compensated by the permanent torque

$$b\,c\,\mathrm{V}^2 = \mathrm{R},$$

and

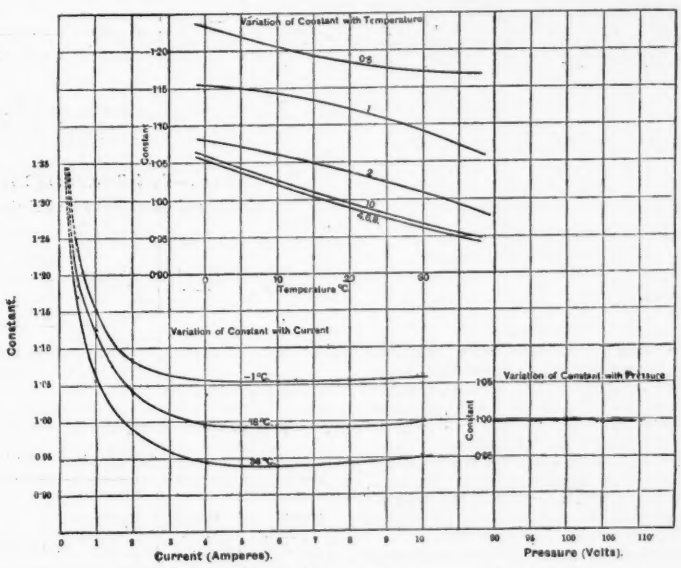
$$\mathrm{A}\,\mathrm{V} = \frac{f^2}{a\,b}\,w.$$

The results of the tests on this meter are given in Table I. and shown graphically on Sheet I. The starting current, below which, of course, the constant is infinite, is about 0·14 ampere, or 1·4 per cent. of the maximum. The constant then falls very rapidly as the current increases; not, however, reaching its normal value till the current has risen to about 40 per cent. of its maximum value after which it remains remarkably constant till within 10 per cent. of the maximum, when it begins to rise slightly. This high value of the constant at small current is, of course, due to the uncompensated part of the solid friction. There are several reasons why it is desirable to not quite compensate for all the solid friction. Not only would it increase the amount of continuously absorbed energy, but the meter would be liable to start without any series current, should the pressure increase slightly. Another consideration is that it is very desirable to keep the self-induction of the pressure circuit as low as possible, in order to lessen the difference which it causes between the direct current and alternate current readings.

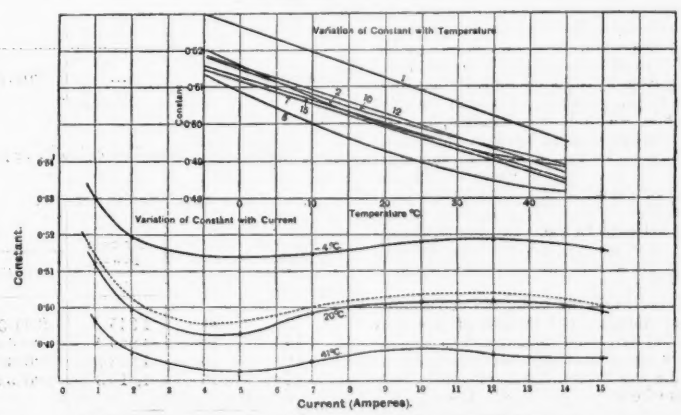
The effect of temperature change is also shown on Sheet I. Except for low currents, where the value of the constant is not so well defined, these curves are practically straight lines. The constant decreases proportionally to ihe rise of temperature, and the temperature coefficient of the meter is therefore negative. Its maximum value is about − 0·32 per cent. per C°; but for currents between 4 and 10 amperes its mean value is − 0·29 per cent. per C°. This coefficient, it will be noted, is not very much less than that of copper, and it may therefore be surmised that the coefficient of the pressure coil is very much less than that of the copper disc.

The tests made with varying pressures show that the accuracy of the meter's indications is quite independent of the pressure when varied within 10 per cent. of the normal value.

This meter posseses some very useful advantages compared with meters generally. It is comparatively simple in construction and is equally applicable without any modification to either alternating or direct current circuits. As already pointed out, its constant is remarkably accurate for currents above 40 per cent. of the maximum; for low currents, however, the error is considerable. The power absorbed is also fairly large: the pressure circuit takes 3·2 watts, and the series coils at full load 9·6 watts, so that at full load the wasted power is 1·28 per cent. of the maximum power, and at no load about 0·32 per cent.



Sheet I.—Elihu Thomson Meter (Max. Current, 10 Amperes; Pressure, 100 Volts).



Sheet II.—Schuckert Meter (Max. Current, 15 Amperes; Pressure, 110 Volts).

Schuckert Meter.

This meter is exactly the same in principle as the Elihu Thomson meter, and is very similar to it in construction. It consists essentially of a small electrometer in which no iron is used, and whose motion is retarded by Foucault current friction. In fig. 4, A is the armature, wound with fine wire, and having in series win it a high resistance, part of which is wound to give a permanent driving torque, the remainder, B, being wound non-inductively. The field is produced by main current in the series coil, $\mathrm{C_1}$, $\mathrm{C_2}$, and the retarding torque is obtained by the action of the permanent magnets, M, on the copper brake disc, D. The equation of motion of this meter is of course identical with that of the Elihu Thomson meter, which has just been described, and the statement given there is equally applicable to the Schuckert meter.

The curves on Sheet II. show the results of the tests on this meter. Referring to this sheet, it will be seen that the constant, after starting, as the current is increased, rapidly approaches its declared value, falling below it at about 15 per cent. of the maximum current. The curve then dips down, but rising again crosses the declared value at about 50 per cent. of maximum current, after which it remains fairly constant till near the maximum, when it decreases slightly. The high value at low current is, of course, due to the uncompensated solid friction, but the reason for the shape of the remaining part of the curve is not apparent.

The effect of temperature is also shown on Sheet II.; the mean temperature coefficient is about 0·13 per cent. per °C. This is much lower than the coefficient of the Thomson meter, and may possibly be due to a larger coefficient in the pressure circuit. It will be seen from Table II. that varying the pressure has no appreciable effect on the accuracy of the meter.

The starting current was found to be rather high, being 0·29 ampere, or 1·93 per cent. of the maximum. The absorption of power is also very considerable, being 14·7 watts at maximum load, and 4·8 watts at no-load. The fall of potential in the series coils is 0·66 per cent.

The general characteristics of this meter are much the same as those of the Thomson meter. The constant approaches its normal value at a much lower percentage current, but on the other hand the remaining part of the curve is less regular.

Ferranti Meter.

The action of this meter is dependent on the principle that when a current is passed radially through a fluid which is in a perpendicular magnetic field, the fluid tends to move in a direction at right angles to the directions of both the current and the field.

A diagram of its construction is shown in fig. 5, where T is a disc-shaped insulated chamber containing mercury. It is made of vulcanised fibre, and is fixed to the magnet pole, $\mathrm{M_2}$, the other pole, $\mathrm{M_1}$, being close above it. The electro-magnet is energised by the main current in the coil, c, and is so designed that only the comparatively straight part of the magnetisation curve is employed—that is, the magnetic field is very nearly proportional to the main current. The current enters the meter at the terminal, $\mathrm{T_1}$, which is connected with the iron case, I, it passes up $\mathrm{M_2}$, and enters the mercury at the central part, T, and flowing radially outwards, enters the coil, c, by means of a metal rim, and then leaves the meter by the insulated terminal, $\mathrm{T_2}$.

The chief retarding force is that due to fluid friction of the mercury against the sides of its chamber, which are stamped with radial grooves to increase the effect and make it proportional to the square of the speed over as large a range as possible. The counting mechanism introduces a small amount of solid friction, which is practically constant and is compensated for by using mild steel for the magnet core, which then has a small amount of permanent residual magnetism. The motion of the mercury is transmitted to a very delicately made counting mechanism by means of a vane immersed in it, and having a small vertical spindle which gears into the counting mechanism. Very pure mercury is used and the spindle is of very small section at the part where it breaks the surface, so that skin friction is not very great.

(To be continued.)

THE COST OF STEAM POWER.*

By HORATIO A. FOSTER.

(*Continued from page* 332.)

For the sake of uniformity, as well as to reduce the items of account to as small a number as was considered consistent with clear understanding, a list of cost accounts was determined on, that in most ways agrees with work previously done in this line, and which it was thought could be most easily met by the most ordinary book-keeping.

The list is as follows:—

Operating Expenses.
- Fuel.
- Wages.
- Supplies.
- Repairs.
- Water.
- Incidentals, including lighting and removal of ashes.

Fixed Charges.
- Interest on cost of plant.
- Depreciation on value of plant.
- Insurance.
- Taxes.

In considering the value to be given to each item, many things had to be discussed in order that proper separation of expenditure due to items other than for power could be made, as for instance, the item of fuel; in many cases buildings have had to be heated, either by exhaust or live steam; steam has been used for hot tables, as in the case of newspaper offices, and for dry rooms, for lumber, &c., as is the case of a furniture factory. In all such cases the study of the plant, consultation with the engineer in charge and the management, coupled with the experience of the writer, has ensured the determination of an amount satisfactory to all concerned as being the nearest correct obtainable under the ordinary conditions of practice.

In the item coming under the head of fixed charges, a somewhat different treatment obtained, as so little attention is given these items by the ordinary business management that in most instances not only the value of the plant, but the items going to make up the fixed charges had to be determined by the writer from his experience, together with such information as could be gotten from the people in charge. While insurance and taxes were, of course, determinable from the books, interest was rated in almost all cases at 5 per cent.; and depreciation at rates varying from 2½ to 10 per cent. for building and 5 to 15 per cent. on steam plant, all according to type of material in use, its condition, the manner in which it was handled, &c. In but few cases were either of these items considered in these estimates of cost by the owners. It must be remembered in this connection, that fixed charges go on all the time, 24 hours per day for 365 days, and that the unit cost is the same if computed by the year, but does not have the same relative value when computed by the number of hours the power was actually in use. In passing, it may be well to say that the number of firms in good business standing that are entirely at sea regarding the actual cost or present value of power plant is, to say the least, astonishing.

One item taken into consideration in all the tests, and one seldom considered at all in the ordinary statements of the cost of power, is the value of the building or part of the building devoted to the use of the power plant. In some few cases buildings were set apart for this purpose, and where the value was known it was, of course, easy to fill out the item; but in cases where the power plant was in the same building with the other portion of the plant, it became necessary to set off the value from the rest, and this was most often done by determining the renting value of the room used, which can usually be done with small chance of error, and then to capitalise the rent as the value of that part of the building devoted to power purposes.

In one item used in these tests, the writer apparently differs from most other estimators of the cost of power, and this is the use of the indicated horse-power rather than brake horse-power for the divisor, and his reasons for using it are as follows, viz., indicated horse-power can nearly always be determined to a degree of accuracy only limited by the usual errors of instruments and their users, generally conceded to be small; while brake tests can seldom be made in practice, and the net power is therefore most often determined by assuming a certain percentage of engine and shafting efficiency which under general conditions is quite incapable of proof, and the errors of which must be added to those of the indicator test. The writer therefore prefers to eliminate this chance of error, and should anyone desire to change the figures here displayed to brake horse-power, it is only necessary to make the single computation due to any engine efficiency that he may wish to assume.

Referring now to plants tested, those on which reports were made were not selected in order to show the very considerable variation in results that are given, but for availability and for variety of types and of business.

The plants on which tests were made for unit cost of power were 22 in number as follows:—

Two electric lighting stations.
One grain elevator.
Three water works pumping stations.
Two flouring mills.
Six cotton mills.
Four newspaper and printing offices.
One department store.
One furniture manufactory.
One bakery.
One glazed and fancy paper manufacturing company.

Table XII.—*Coal reduced to* $3.00 *per* 2,000 *lbs. Slow Speed. Condensing.*

Number of plant.	Hours run.	Average power.	Expenses.		
			Operating.	Fixed.	Total.
2	24	210 9	$·00785	$ 00113	$ 00898

Table XIII.—*Coal Reduced to* $3.00 *per* 2,000 *lbs. Combined, Compound Condensing and Automatic Non-Condensing.*

Number of plant.	Hours run.	Average power.	Expenses.		
			Operating.	Fixed.	Total.
6	23	70·4	$·01573	$·00273	$ 01851

Table XIV.—*Coal Reduced to* $3.00 *per* 2,000 *lbs. Pumping Engines, Compound Condensing.*

Number of plant.	Hours run.	Average power.	Expenses.		
			Operating.	Fixed.	Total.
9	24	1,352	$·00455	$·00336	$·00791
10	24	36·7	·01887	·01161	·03048
11	24	42·4	·01149	·00722	·01871
Averages	...	...	·01174	·00739	01913

Table XV.—*Coal Reduced to* $3.00 *per* 2,000 *lbs. Slow Speed Compound Condensing.*

Number of plant.	Hours run.	Average power.	Expenses.		
			Operating.	Fixed.	Total.
7	11	1 345	$ 00235	$ 00235	$ 01136
18	10	926 0	·00447	·00295	·00742
21	10	1,278·7	·00414	·00220	·00634
22	10	1,010 8	·00522	·00262	·00784
Averages	...	...	·00571	·00253	·00824

Table XVI.—*Coal Reduced to* $3.00 *per* 2,000 *lbs. Slow Speed Triple Compound Condensing.*

Number of plant.	Hours run.	Average power.	Expenses.		
			Operating.	Fixed.	Total.
17	10	1,174·8	$·00318	$·00186	$·00504

* Abstract of paper read before the American Institute of Electrical Engineers, July 26—28th, 1897.

Table XVII.—*Coal Reduced to* $3.00 *per* 2,000 *lbs. Combined, Compound Condensing and Simple Condensing.*

Number of plant.	Hours run.	Average power.	Expenses.		
			Operating.	Fixed.	Total.
19	10	2,422·	$·00460	$·00227	$·00687
20	10	1,909·7	·00527	·00224	·00751
Averages	...	...	$·00494	$·00225	$·00719

Table XXIII.—*Cost of Power, from Table in "Engineering Magazine," by Dr. Emery. Coal Reduced to* $3.00 *per* 2,000 *lbs.* 3,080 *hours.*

	Net horse-power.	Cost per H.P. per hour.
Ordinary non-condensing	10	$·02570
Automatic cut-off, non-condensing	75	·01396
Automatic cut-off, condensing ...	150	·01060
Compound condensing	250	·00856
Triple compound condensing ...	500	·00727

The criticism may be offered that not enough plants were tested in any one business to determine an average cost of power in that business, and a careful inspection of the accompanying tables will show that comparisons of cost of power between unlike types of business are of little value, and if still further comparisons be made, it will be found that conditions vary so much in the same type of business as to show that any statement of an average cost of power even there is quite misleading and that therefore tests of even a single plant of any of the different classes of business is of value only so far as it determines the cost for that plant alone, and demonstrates the fact, of which the writer has become thoroughly convinced, that each plant must be tested as if it were the only one of the type in existence.

In rated capacity the plants vary from 40 H.P. to 2,500 and in value per rated horse-power from $23 to $89 in steam power plants, or as high as $368 in water works pumping stations.

While the type of boiler used leans largely to the plain, old-fashioned return tubular, with the exception of the cotton mills, the types of engines are almost as varied as the number of plants.

In fuel, soft coal or slack of soft coal largely predominates, and a considerable use of mixtures of the latter with dust from the yards and hard coal slack will also be noticed, which is largely due to efforts to reduce the smoke nuisance.

In Tables IV. to IX. the results from the different plants have been separated and classified according to the hours per diem during which they are run, making the broad distinction of 20 to 24-hour runs and 9 to 12-hour power. There are, however, two plants that, owing to wide difference of running time could not be brought under these headings, and they have therefore been placed by themselves in Tables VI. and IX. In considering the plants under these general divisions, it must still be borne in mind that while they are classed under the same heading in hours per diem, they are by no means all run the same number of days per year, and therefore the total hours per annum during which the plant was run become the only correct basis on which to compute the cost for comparison.

While the above 22 plants are the only ones on which tests available for this paper were carried out, many others were examined during the time, and while it may be said that in most plants fairly accurate tests may be made, some are found in which it is next to impossible to arrive at anything like accurate results.

Until one makes a business of examining power plants with an idea of learning the unit cost of power, it is impossible to judge adequately of the varying conditions obtaining, and, therefore, of the fact that any possible statement of an average cost is misleading.

It has been the writer's experience that one of the greatest factors for varying the cost of steam power in a given plant is to be found in the fire room.

In but few plants is this part of the expense found to receive the attention it should have to obtain the best results; and, as a whole, the men employed at the work of firing are of a class that seldom runs to brains, and unless pushed to it by the management, the engineer is prone to exercise only a nominal supervision over the department. When a fireman on one shift can use nearly twice as much coal doing the same work as the fireman on the other shift, as was found in one case, it is time the engineer was disposed of or new methods arranged.

In plants developing a low amount of power, say, less than 100 H.P., as a large majority of them do, the labour item, due to varying conditions of the business, becomes a very important factor, and one in which great saving can be made by re-arrangement of power supply.

In order to make this paper of greater value, the writer has thought it well to add the results of estimates by other investigators, and, as coal is the only item that varies to a great extent in unit price, it has been thought best to bring that item to the same price per ton, and, as the ton used in the neighbourhood where most of the tests were made is 2,000 lbs., all weights and prices have been reduced to a cost of $3 per 2,000 lbs., delivered.

Tables X. to XVII., inclusive, are the results of the tests by the writer, classified by types of plant, and reduced to coal at $3 per 2,000 lbs. Table X. shows the costs for slow speed, non-condensing engines, irrespective of the size or number of hours run per diem. Although an average is taken of these, it is, of course, of little value, as the costs vary, not only by reason of the amount of power developed, but from the number of hours run per diem, and the variety of each of these conditions is such that each item could as well be placed by itself.

(*To be continued.*)

ELECTRIC RAILWAY DEVELOPMENTS.

Probably the most important improvement or development yet effected in electric traction since the series parallel controller method came into use, is that just chronicled by the American electrical papers as being in experimental service on a short private track at the Schenectady works of the General Electric Company.

It is due to the well-known F. J. Sprague, who, after being one of the first in the electric traction field ten years ago or more, and who then deserted it to make improvements in electric lifts and elevators, seems now to have returned to his old love, with mutual advantage, let it be hoped. Considerable credit, at any rate, is due to him for the device now under notice, for it will if thoroughly successful effect great improvements and economies in railroad working.

Briefly, the idea may be stated to comprise the equipment of all cars with electric motors so that they may run separately and individually if required, under ordinary methods of control. Over and above all this, however, Mr. Sprague so designs the regulating and controlling gear of each car that any number may be combined to form a train; all the cars are then operative, that is, the motors of each car can help to draw their portion of the entire load; but the regulation and control is effected at the front end of the train. Of course the idea is not a new one altogether; that is, the need of some such device has been recognised for some time, and several other inventors have made efforts to design a satisfactory way out of an obvious difficulty.

Mr. Sprague, however, is the first to put into actual operation any method of controlling an entire train of independent motor cars, so designed, that the train may be broken up and remade without the least trouble, and we congratulate him thereon. Doubtless we shall be able to do so again on learning fuller particulars of the special apparatus and mode of working which Mr. Sprague has introduced. At present the information to hand is of somewhat too general a character to enable us to say whether the Sprague system is at once likely to become standard, or whether there may be obvious improvements to suggest, and faults to criticise.

Assuming that all the cars on any electric road are duly equipped with motors, controlling and regulating gear, &c., the problem has been to instal some additional regulation appliance throughout the train of such a character as to move all the individual car controllers in synchronism. In the Sprague system, so far as we can gather, this is done by means of a special motor to each car controller, operated by magnets; the handle for starting and stopping this motor is all that need appear on each car platform, the actual series parallel controllers being stowed away in any suitable place, under the seats, the end platforms, or canopies. It will be evident, moreover, that only one controller is required for each car, instead of two, as at present.

The description so far given of the platform appliance is as follows:—On the end platform of each car is a small operating switch enclosed in a circular box mounted on an upright pipe. Inside the box are several contact blocks on each side of a central normal position to which the handle is always automatically brought back by springs. This position cuts off current from all the motors. Air brakes with separate compressing motors, &c., are provided and operated from any of the car platforms, so that the man in charge of the train on whichever platform he may be is always able to control the entire train.

At the trial runs which took place a few weeks ago we understand that in order to show the elasticity of this system, a variety of tests were made, such as the cutting in or

out of motors while the train was in motion; the coupling up and uncoupling of cars to the train when running; also controlling the train from any platform, and even from cars with their motors cut out and therefore acting as trailers.

We hope to publish full details of the platform regulating gear as soon as they can be obtained; for a development of this kind ought to have a most powerful influence in securing the adoption of electricity for suburban and underground lines, perhaps even for short main lines also when railway managers can bring their directors up to the sticking point.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 322, *High Holborn, London, W.C., to whom all inquiries should be addressed.*]

19,955. "Improvements in and relating to sleeves and sockets chiefly designed for simultaneously connecting globes, reflectors and the like to electrical incandescent lamps." C. Bartenstein. Dated August 30th.

19,959. "Process and apparatus for electro-thermally treating materials." H. Maxim. Dated August 31st.

19,995. "Improvements in means for effecting magnetic transmissions." G. Englisch and T. Konig. Dated August 31st.

20,003. "Improvements in electric light arc lamps." A. Casey. Dated August 31st.

20,041. "Improvements in metal bases for telegraph and other poles." G. W. Glazier. Dated August 31st. (*Complete.*)

20,092. "Improvements in electric lamps for use in mines and for other purposes." T. W. Allan and A. G. Adamson. Dated September 1st.

20,145. "Improvements in accumulator plates." A. Lehmann and A. Mann. Dated September 1st.

20,166. "Improved indicating apparatus for electric lamps." J. Marr. Dated September 2nd.

20,174. "Improvements in incandescent gas, electric light and oil lamps hanging pendants and brackets for advertising purposes." L. E. Wood, T. B. Davis and A. Mawson. Dated September 2nd.

20,234. "Improvements in electrical apparatus for signalling to or from a railway train or locomotive." R. Buan, A. C. Brown and L. G. Tate. Dated September 3rd.

20,263. "Improvements in electric high and low tension fuse heads for blasting purposes." W. A. Malson and S. R. Malson. Dated September 3rd.

20,316. "Improvements in electric fire engines." G. C. Dymond. (G. W. Cox and E. E. Smull, United States.) Dated September 3rd.

20,317. "Improvements in or relating to dynamo electric machinery." C. L. Rosenqvist. Dated September 3rd.

20,325. "Improvements in electric light fittings." A. E. Salt. Dated September 3rd.

20,334. "Improvements in telegraphy." A. A. C. Swinton. Dated September 4th.

20,394. "An improved arrangement for strengthening electric currents." M. R. Von Leon. Dated September 4th. (*Complete.*)

20,398. "An improved electric meter for alternating or continuous currents." P. R. Blandlat. Dated September 4th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps).*]

1896.

2,610. "Improvements in the construction of dynamo-electric machines and electromotors." E. S. G. Rees. Dated February 5th, 1896. The invention relates to two-pole dynamo-electric machines and motors of the ironclad type in which the pole-pieces stand outward from the magnet coils, and to facilitate the inspection and removal of the armature and of the magnet coils. The type of electro-magnet described is that in which the magnet coils are placed round only one magnet limb, the centre line of which (taken in a plane parallel to a plane of rotation) is radial to the centre of the armature shaft, the upper or outer end of the limb, next to the armature being attached to one pole-piece, and the magnetic circuit being extending symmetrically on two opposite sides of the magnet winding passing the armature at a sufficient distance to prevent undue magnetic leakage, and meeting on the upper or outer side of the armature to form the other pole-piece; and this improvement consists in making this upper pole-piece hinged in such a manner that it may be turned back on its hinges to expose the upper portion of the armature to be readily inspected and, if desired, lifted out from its bearings and removed from the machine. 2 claims.

4,404. "Improvements in electric switches." B. M. Drake and J. M. Gorham. Dated February 27th, 1896. Relates to a switch for showrooms, which will enable any one of a number of lamps on show to be readily lit. A radial arm revolves round a centre fitted with a contact and spiral spring to ensure contact. This arm enters a number of springing contacts, and the board carrying the contacts is hinged so that the wires can be connected at the back and the board closed to make a neat finish. The centre contact is provided with a fuse so as to guard any circuit supplied with current. 3 claims.

6,058. "Improvements in moderating electric incandescent lamps and apparatuses for that purpose." G. Bamberg. Dated March 18th, 1896. The incandescent lamp has a three-way filament joined together to form one piece, the three ends being connected to a collar base having one central or two side contacts, whereby an alteration in the intensity obtained from, is regulated from outside by causing the whole or only a portion of the filament to glow, and effecting said alteration in the intensity of light emitted by sending current from one outside contact plate to the other, or by sending current in at the centre and out at the two side contacts. 3 claims.

6,306. "Improvements in electric motors." A. Greenwood. Dated March 21st, 1896. The improvements are for protecting the working parts of an electric motor and at the same time allowing the coils, cores and pole pieces to be removed without disturbing the armature. For the casing an ordinary framework consisting of a rectangular casing with a central opening in the sides is provided. One opening is sufficiently large to allow of the insertion of the armature and its shaft, and the other for the projection of the shaft through the opening. The opening is covered by a plate which carries the bearing for one of the journals of the armature shaft, and is secured in its place by bolts. The larger opening in the case is surrounded by a cylindrical extension of the case, which cylindrical extension is fitted with a bearing for the other journal of the armature shaft. A cover serves to close this extension of the case. The top and bottom of the case has detachable covers bolted to it pendent from and attached to them are the core pole pieces of the field magnets. Fitted to the armature shaft is the commutator and in contact with the commutator are carbon brushes pendent from a yoke which is made fast adjustably to the bearing carried by the cylindrical extension of the case. Externally of the casing is provided suitable gearing which is also protected by a cover. 2 claims.

6,751. "Improvements in or appertaining to carbons for electrical purposes." W. P. Thompson. (A. Lessing, Nuremburg). Dated March 25th, 1896. The invention relates to carbons for electrical purposes, particularly to the attachment of binding screws. Screw threads are impressed in fresh carbons by means of a sharp steel screw the diameter of which exceeds that of the screw which is to be subsequently inserted by an amount equal to the shrinkage of the carbon by heating. The screw may be pointed at the end in order to allow of its being readily screwed in. 1 claim.

7,389. "Improvements in telephone transmitters." W. L. Wilhelm and J. Tillman. Dated April 7th, 1896. The invention relates to that class of telephone microphones or transmitters which contain two separate diaphragms bearing against opposite sides of the same electrode and a single mouthpiece from which the round is delivered by two branch tubes against both diaphragms. The apparatus consists of a mouthpiece and two branch tubes connected at their front ends with the rear end of the mouthpiece. Two vertical supporting discs are secured to the open rear ends of the branch tubes and arranged parallel. The supporting discs are separated from each other along their entire opposing surface thereby forming an opensided chamber between the supporting discs into which the transmitting devices can be inserted from the side for assembling the parts or to be removed for repairs. A rotary supporting frame is held between the discs by friction and is provided on opposite sides with annular seats. Two separated diaphragms of carbon are filled with their marginal portions against the seats of the frame. A carbon dust electrode is arranged between the diaphragms and being retained in position by a resilient ring, such as cotton wool or eiderdown. Two contact springs are arranged to form the terminals of the conducting wires and are adapted to make connection with the carbon diaphragm when the transmitting devices is in its operative position. 4 claims.

23,127. "Improvements in or connected with arc lamps." F. M. Lewis. Dated October 21st, 1896. The invention relates to details in connection with the construction and running of arc lamps. A cord to the end of which the carbon holders are attached passes round a toothed pulley mounted loose on an axle, the ends of the latter being fixed in bearings framed in the hanging brackets. The carbons are fed together by gravity, *i.e.*, by the superior weight of the top carbon holder. On the same axle and fixed to the toothed pulley is mounted a ratchet wheel. In the same brackets are formed the bearings for a fixed axle which carries a two-armed lever, one side of which is attached by means of a fork and pen to the core of the solenoid. The opposite side of the lever is formed with a foot provided with a hinged pawl the back of which is pressed by a spring tending to force the opposite end into gear with the ratchet wheel. The motion of the pawl with respect to the foot is limited by a projecting stop piece on the foot so that when the foot is drawn back or raised sufficiently by the movement of the lever the pawl comes out of gear with the wheel, owing to the different positions of the fulcrum of the lever and centre of the ratchet wheel, and allows the latter and the pulley to rotate *i.e.*, the carbons to feed or approach each other. Improvements in the details are mentioned, such as the construction of a skeleton holder for solenoids, &c. 8 claims.